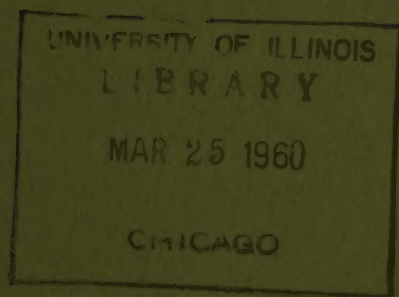


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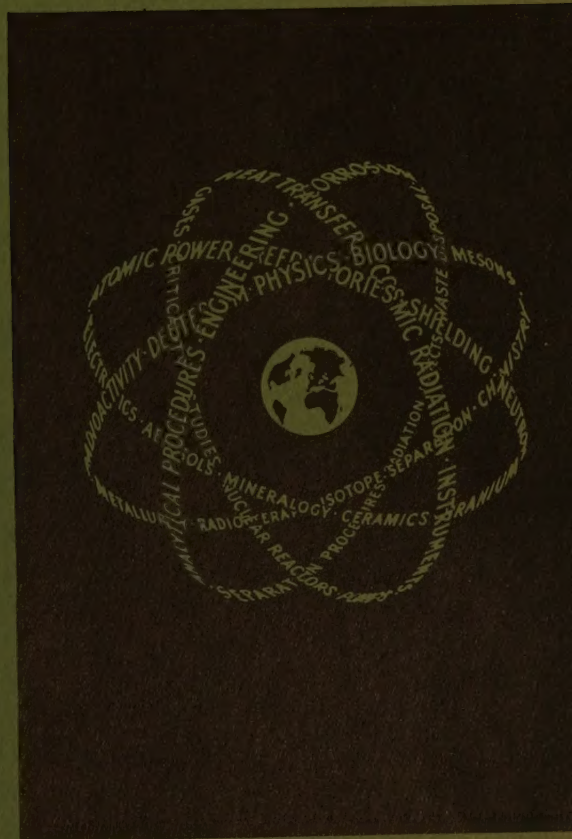
# NUCLEAR SCIENCE ABSTRACTS



*February 29, 1960*

Volume 14 Number 4

Abstracts 3260-4146



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# NUCLEAR SCIENCE ABSTRACTS

Volume 14 Number 4

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## GENERAL AND MISCELLANEOUS

**3260** AECU-4499

Los Alamos Scientific Lab., N. Mex.

AIR FLUORESCENCE IN THE UPPER ATMOSPHERE AND ITS RELATION TO THE DETECTION OF NUCLEAR EXPLOSIONS IN SPACE. D. R. Westervelt. June 19, 1959. 25p. Contract W-7405-eng-36. OTS.

A nuclear explosion far from earth is a strong source of thermal x rays that deposit their energy in the upper atmosphere and cause air fluorescence. Methods of detecting such explosions by ground instrumentation are examined. The x-ray energy deposition and the resulting air fluorescence are considered and properties and limitations of typical detection apparatus are described. Suppression of x-ray flux in a particular direction by shielding is also considered. (J.R.D.)

**3261** NP-8089

Ramo-Wooldrige Corp. Guided Missile Research Div., Los Angeles.

ON THE SAFETY OF STRUCTURES AGAINST GROUND SHOCKS. Y. C. Fung. June 15, 1957. 16p. Contract AF18(600)-1190. (GM-TR-191).

Some formulas useful in the analysis and application of ground shock information with a view either to estimating the safety of an existing structure against ground shocks or to designing economically a supporting structure which will protect the main structure against ground shocks are reported. (W.L.H.)

**3262** TID-3539

Technical Information Service Extension, AEC.

INDUSTRIAL APPLICATIONS OF RADIOISOTOPES AND ASSOCIATED TECHNIQUES. A Literature Search. Raymond L. Scott, comp. Nov. 1959. 30p. OTS.

This literature search contains 268 unclassified references on industrial applications of radioisotopes and associated techniques. (W.L.H.)

**3263** NP-tr-306

NUCLEAR DETONATION AND SOME PROBLEMS IN ATOMIC DEFENSE. A. V. Bibergal' and I. Ya. Margulis. Translated from a publication of the State Publishing House of Medical Literature, Moscow, 1958. 68p. OTS

Information published to familiarize the Russian population with the characteristics of atomic bomb effects is presented. Protective measures are described and the principal rules of behavior during attack are delineated. In addition, a layman's language of atomic physics review covering radioactivity, fission, and fusion is presented. (J.R.D.)

**3264**

BOUNDARY CONDITIONS FOR NUCLEAR PROPULSION.

Robert W. Bussard (Los Alamos Scientific Lab., N. Mex.). *Astronautics* 4, No. 10, 28-9; 119-22(1959) Oct.

Rocket-vehicle performance is analyzed and relations between nuclear-rocket motor, propellant pumping plant, propellant, propellant tank structure, and deadload defined to include all remaining equipment, are graphically expressed. Performance curves are given for hydrogen (propellant density = 4.4 lb/ft<sup>3</sup>) and ammonia (propellant density = 44 lb/ft<sup>3</sup>) in terms of propellant performance and peak operating temperature up to 50,000°R for an isentropic nozzle expansion efficiency of 80 per cent. Nuclear propulsion performance curves are given in terms of reactor-fuel loss and propellant specific impulse vs. vehicle characteristic velocity. A design is given for a regeneratively-cooled nuclear and electric propulsion system. Free-fall flight must involve accelerations of the order of 10<sup>-4</sup> to 10<sup>-3</sup> g<sub>c</sub>. Nuclear-rocket-motor specific power output should be aimed for the range 0.5 < K<sub>r</sub> < 1.5 Mw/lb for ground-launched nuclear-rocket vehicles. Propellant specific impulse should be in the range 1000 < I<sub>sp</sub> < 2500 sec for NH<sub>3</sub> and 2000 < I<sub>sp</sub> < 5000 sec for H<sub>2</sub> for a useful payload capacity. Gaseous reactors should be able to operate at peak temperatures of 20,000 < T<sub>c</sub> < 60,000°R. (C.J.G.)

**3265**

THE APPLICATION OF RADIOACTIVE SUBSTANCES.

Hans Götte (Farbwerke Hoechst AG, Frankfurt am Main). *Atomwirtschaft* 4, 408-13(1959) Oct. (In German)

Radioactive isotopes find extensive application in engineering, research, medicine, and agriculture through their use for irradiation purposes, radioactive tracer, and analysis techniques. Examples are given from the spheres of plastics, technology, pest control, preservation, the investigation of the course of reactions, and radiometric analysis techniques. (auth)

**3266**

THE PAYLOAD CAPABILITIES OF ION PROPULSION ROCKET SYSTEMS. Robert H. Fox (Univ. of California, Livermore). *J. Astronaut Sci.* 6, 33-9(1959).

The relationship between booster performance, ion propulsion system characteristics, mission, and payload is discussed for the simple case of zero gravitational field. It is shown that appreciable increases in payload can be obtained by varying the exhaust velocity in the appropriate way. (auth)

**3267**

THE ATMOSPHERE AS A RADIATION FILTER, RADIATION SOURCE, AND CARRIER FOR RADIATING SUBSTANCES. Rudolf Schulze. *Med.-Meteorol.*, No. 13, 127-41(1958). (In German)

On the basis of the atmosphere as a radiation filter, radi-



ation source, and carrier for radiating substances, the various types of radiation are described physically with respect to the irradiation intensity and fluctuation, and are investigated biologically with respect to probable effect on man. The atmosphere acts as a filter for radiation wave lengths except for visible light and the near infrared and for wave lengths between  $10^{-2}$  and  $10^2$  m. These radiations have very little biological effect on men. In addition to acting as a filter the atmosphere is the source of two radiations, a long-wave infrared radiation in the range from 6 to  $60\mu$  and a radiation in the broadcast band with a wave length from 1000 to 100,000 m. The biological effects of these radiations are considered. The atmosphere also serves as a carrier for natural and artificial radioactive substances. The origin and biological effects are discussed (J.S.R.)

**3268**

SOLID-FUEL ROCKET CHAMBERS FOR OPERATION AT 240,000 PSI. AND ABOVE. II. M. E. Shank (Massachusetts Inst. of Tech., Cambridge, Mass.) and C. E. Spaeth, V. W. Cooke, and J. E. Coyne (Pratt and Whitney Aircraft Corp., [Middletown, Conn.]). Metal Progr. 76, No. 6, 84-93(1959) Dec.

In hydrostatic tests on solid-fuel rocket chambers designed to operate at 240,000 psi tangential stress, one full-scale vessel failed. Hydrostatic tests on six subsized vessels found the water used in the testing to be responsible, causing delayed, hydrogen-induced fracture. Decarburization to a depth of 0.005 in. helped in preventing surface cracks from spreading. From the study it was found that solid-fuel rocket cases with tangential stresses of 240,000 psi are practical. Stresses of 260,000 psi appear possible if small plastic strains can be tolerated. (C.J.G.)

**3269**

OXYGEN ISOTOPE VARIATIONS IN ANTARCTIC SNOW SAMPLES. R. Gonfiantini (Universita, Pisa, Italy) and E. Picciotto (Université, Brussels). Nature 184, Suppl. No. 20, 1557-8(1959) Nov. 14.

The oxygen-18/oxygen-16 ratio was measured in samples of snow collected at the King Baudouin Base in Antarctica. The results are expressed in terms of relative deviation per mille ( $\delta$ ). The average value of  $\delta$  is about -25, in good agreement with the multiple-stage distillation model proposed by Epstein and Mayeda. (C.J.G.)

**3270**

RADIOAKTIVNYYE IZOTOPY I IKH PRIMENENIYE. (Radioactive Isotopes and Their Application). Moisey Borisovich Neyman. Moscow, Izd-vo "Znaniye," 1959, 45p.

The discovery, preparation, and utilization of radioactive isotopes in many branches of the national economy are discussed. It is noted that extending the utilization of synthetic materials and the products of nuclear fission and radioactive isotopes is one of the problems in the current development of Soviet industrial capacity. The application of radioactive isotopes in industry, agriculture, research, and medicine resulted in a saving of some 1.5 billion rubles to the national economy in 1957. (TCO)

**3271**

PROCEEDINGS OF THE AMERICAN POWER CONFERENCE MARCH 31, APRIL 1-2, 1959. Volume XXI. Chicago, Illinois Institute of Technology, 1959. 806p. \$8.00.

**3272**

NUCLEAR POWER PLANT SAFEGUARDS AND CONTAINMENT. Robert H. Shannon (United Engineers and Constructors Inc., Philadelphia). p.60-89 of "Proceedings of the American Power Conference, March 31, April 1-2,

1959. Volume XXI." Chicago, Illinois Institute of Technology, 1959.

It is impossible to design, construct, and operate a nuclear power plant in such a way as to ensure or guarantee absolute safety. The material covered is limited to power reactors utilizing conventional heat-power cycles for producing electric power. Types of reactor accidents are discussed and the potential dangers of a reactor and associated facilities are treated. Items considered are control and safety systems, safety design philosophy, maximum credible accidents, design and construction codes, containment, site selection, radiation exposure, waste disposal, and fuel cycles. Current regulations and procedures covering permits and licenses for nuclear power plants are appended. (W.D.M.)

**3273**

A PEBBLE BED REACTOR STEAM POWER PLANT. S. T. Robinson and R. F. Benenati (Sanderson and Porter, New York). p.90-9 of "Proceedings of the American Power Conference, March 31, April 1-2, 1959. Volume XXI." Chicago, Illinois Institute of Technology, 1959.

From a study of various reactor types emerged the pebble bed reactor: a gas-cooled, graphite-moderated system in which the fuel in ceramic form is embodied in a spherical matrix. This is a thermal reactor, applicable as a  $U^{235}$  converter or a Th- $U^{233}$  breeder. The pebble bed reactor, fuel, fuel cycle, and some of the salient features of the system are described. (W.D.M.)

**3274**

PROGRAMMING FOR ECONOMIC NUCLEAR POWER. Karl Cohen and E. L. Zebroski (General Electric Co., San Jose, Calif.). p.100-19 of "Proceedings of the American Power Conference, March 31, April 1-2, 1959. Volume XXI." Chicago, Illinois Institute of Technology, 1959.

The technical status, current and projected economics, and the nature of developments which are needed to increase performance to competitive levels are reviewed for boiling water reactors. A pattern of development, including small- and medium-sized reactors is presented, and this is compared with the British program with gas-cooled reactors. (W.D.M.)

**3275**

LARGE ORGANIC COOLED POWER REACTORS. Ralph Balent (Atomics International, Canoga Park, Calif.). p.120-31 of "Proceedings of the American Power Conference, March 31, April 1-2, 1959. Volume XXI." Chicago, Illinois Institute of Technology, 1959.

The early history and applications of the organic-cooled power reactor concept are briefly reviewed, and the Organic Moderated Reactor Experiment is outlined. Physical properties of organic coolants (polyphenyls) are discussed in terms of radiolytic damage, pyrolytic damage, and heat transfer. Design features of the organic reactor concept are summarized, and future trends in coolants, fuels, and economics are discussed. (W.D.M.)

**3276**

A NEW METHOD FOR THE CONTINUOUS ANALYSIS OF DISSOLVED OXYGEN IN WATER. J. M. Wright and W. T. Lindsay, Jr. (Westinghouse Electric Corp., Pittsburgh). p.706-21 of "Proceedings of the American Power Conference, March 31, April 1-2, 1959. Volume XXI." Chicago, Illinois Institute of Technology, 1959.

The reaction of dissolved oxygen with some other material to produce a measurable change in the electrical conductivity of a solution is the principle of several devices for the continuous determination of dissolved oxygen. The



results of a series of tests have shown that a dissolved oxygen analyzer using thallium as a solid reactant is a satisfactory instrument for many applications. The method appears promising for measurement of concentrations in the parts-per-billion range. (W.D.M.)

**3277**

**STRESS CORROSION OF STAINLESS STEEL AND BOILER WATER TREATMENT AT SHIPPINGPORT ATOMIC POWER STATION.** W. J. Singley and I. H. Welinsky (Westinghouse Electric Corp., Pittsburgh) and S. F. Whirl and H. A. Klein (Duquesne Light Co., Pittsburgh). p.748-66 of "Proceedings of the American Power Conference, March 31, April 1-2, 1959. Volume XXI." Chicago, Illinois Institute of Technology, 1959.

Following initial operation of the Shippingport Atomic Power Station, leaks were discovered in the stainless steel tubes of one steam generator. The investigations which were conducted to determine the causes of the tube failures are discussed. Tubing failures in the 1-B heat exchanger, boiler water treatment, operating and laboratory tests, and corrective action taken to alleviate the problem are considered. (W.D.M.)

## BIOLOGY AND MEDICINE

### General and Miscellaneous

**3278** AFSWP-1109

Naval Material Lab., Brooklyn.  
**RESEARCH ON THE TEMPERATURES OF RAT SKIN ASSOCIATED WITH NUCLEAR WEAPON THERMAL BURNS. PART 5.** Final Report. G. P. deLhery, W. L. Derksen, and T. I. Monahan. Feb. 20, 1959. 13p. (NML-5046-16(Pt.5); AD-212517).

The Naval Material Laboratory is investigating the protection afforded by various uniforms against the intense thermal radiation associated with nuclear weapons, using rat skin as a control. The temperature histories of irradiated rat skin have been measured on anesthetized rats, uncovered as well as in contact with the Hot-Wet uniform. The rats were irradiated by exposure to a modified 24-in. carbon-arc searchlight whose irradiance was attenuated to simulate the thermal pulse of nuclear weapons having a wide range of yields. (auth)

**3279** CF-59-11-8

Oak Ridge National Lab., Tenn.  
**A DEVICE FOR THE COLLECTION OF FECAL SPECIMENS.** G. F. Stone. Nov. 3, 1959. 7p. OTS.

Certain insoluble radionuclides, when inhaled or ingested, eventually pass through the GI tract and can be detected in the feces. One technique for determining whether or not contamination control measures are effective involves the radiochemical analysis of fecal material. Unfortunately, experience has shown that it is difficult to obtain a fecal specimen under ordinary circumstances without running the risk of cross-contamination. To alleviate the problem of cross-contamination and to gain greater cooperation from the person submitting the specimen, a commode seat adapter with a special plastic bag was designed and installed at the Oak Ridge National Laboratory medical dispensary. After the fecal specimen has been deposited in the bag, the bag with its contents is removed and transferred to a quart size paper carton for transmittal to the laboratory for analysis. The adapter is decontaminated and sanitized after each use. (auth)

**3280** NP-8073

[Illinois. Univ., Urbana].

**TO DETERMINE THE EFFECT OF IRRADIATION UPON THE WHOLESOMENESS OF FOOD.** Progress Report No. 8 [for] March 1959-September 1959. Elwood F. Reber, Om P. Malhotra, J. P. Kreier, P. D. Beamer, and H. W. Norton. 41p. Contract DA-49-007-MD-72800.

Data are tabulated on the following studies: the effects of feeding irradiated beef and flour to dogs; the effect of feeding irradiated beef to rats; the susceptibility to *Salmonella typhimurium* of rats fed irradiated beef; and the effects of extracts of irradiated beef on the growth of cells in tissue cultures. (C.H.)

**3281** NP-8077

Ohio State Univ. Research Foundation, Columbus.  
**THE INFLUENCE OF IRRADIATED FOODS ON THE ENZYME SYSTEMS CONCERNED WITH DIGESTION.** Semi-Annual Report for the Period March 1, 1959-August 15, 1959. (Report No. 5). R. O. Moore. Aug. 17, 1959. 8p. RF Project No. 748. Contract DA-49-007-MD-787.

A rather extensive rat-feeding program was initiated to estimate the influence of irradiation of macronutrients on their digestibility. Purified diets are being used in which the carbohydrate, protein or fat and all combinations thereof are irradiated at one of two irradiation levels. This results in feeding 27 different diets. Digestive coefficients are being determined for the three macronutrients. Data to date do not show obvious effects due to irradiation; the data have not been statistically treated. (auth)

**3282** ORO-217

Tennessee. Univ., Knoxville. Agricultural Research Lab.  
**SEMI-ANNUAL PROGRESS REPORT FOR JANUARY 1, 1959 TO JULY 31, 1959.** 58p. Contract AT-40-1-GEN-242. OTS.

Progress is reported in the following studies: the influence of stable dietary barium, strontium, and calcium on the uptake of barium-138, strontium-89, and calcium-45 by the bones and eggs of chickens and milk in lactating dairy cows; determination of strontium-89 in digestive tract tissues and contents at varying intervals after dosing; the effects of phosphorus intake on metabolism of strontium-89 in digestive tract tissues and contents at varying intervals after dosing; the effects of phosphorus intake on metabolism of strontium-89, calcium-45, and phosphorus-32 in beef steers; the ratio of strontium-89 and calcium-45 in cheese made from milk containing the radionuclides; the metabolism of fluorine-18 in beef heifers and cows after intravenous administration; the metabolism of linoleic- $C^{14}$  acid in chicks; the effect of sulfanilamide on carbonic anhydrase and absorption and excretion of zinc-65, calcium-45, and copper-64; the effect of dietary calcium levels on absorption and excretion of calcium-45, phosphorus-32, copper-64, and zinc-65 in sheep; the relationship of vitamin E to iron metabolism in rats; the effects of radiation on reproductive physiology in swine and rats; the status of burros surviving gamma-neutron irradiation from an atomic detonation; and preliminary studies on the median lethality of Hereford cattle. Fifty-three samples of seed and plant materials were irradiated during the period. Data are tabulated from long-term field, greenhouse, and laboratory studies on agricultural crops grown from irradiated seed. Third-generation data are reviewed for several field crops. (For preceding period see ORO-183.) (C.H.)

**3283** SRIA-9

Stanford Research Inst., Menlo Park, Calif.  
**RADIOISOTOPES AT WORK FOR AGRICULTURE.**



A. Gerlof Homan and Richard R. Tarrice. Oct. 1959. 205p. SRI Project No. IU-2814. Contract AT(04-3)-115, Project No. II. OTS.

An estimate is presented of the probable economic benefits to be derived from the use of radioisotopes in agriculture at present and in the future. A detailed analysis is included of current and probable future uses of radioisotopes in agriculture. An economic framework was developed to give perspective to the use of radioisotopes in agriculture. Data were collected by interviews and questionnaires. (C.H.)

**3284** UR-560

Rochester, N. Y. Univ. Atomic Energy Project. DEPOSITION OF A RADIOACTIVE AEROSOL IN EXCISED GUINEA PIG LUNGS. F. R. Gibb, Paul E. Morrow, and Lucien Dautrebande. Oct. 28, 1959. 19p. Contract W-7401-eng-49. OTS.

This report discusses a series of experiments on the isolated lung. The influence of tidal volume, respiratory frequency, and predilation on the deposition of a sub-micronic aerosol is studied. The radioactive aerosol ( $0.3 \mu$  CMD) used in these studies was prepared by dispersing a hydrosol of calcium phosphate tagged with  $P^{32}$ . The results indicate that the physiologic parameters studied effect changes in aerosol deposition in the isolated lung in the same way as they do in the lung of the intact animal. Predilation of the lung appears to increase mass deposition to such an extent that its possible inclusion in aerosol therapy is suggested. (auth)

**3285** AEC-tr-3661(Bks. 1 and 2)

WORKS OF THE ALL-UNION CONFERENCE ON MEDICAL RADIOLOGY. EXPERIMENTAL MEDICAL RADIOLOGY. (Trudy Vsesoyuznoi Konferentsii Meditsinskoi Radiologii, Eksperimental'naya Meditsinskaya Radiologiya). Translated from a Publication of the State Publishing House of Medical Literature, Moscow, 1957. (Issued in two books: 277p.(Bk.1); 556p.(Bk.2). OTS.

Separate abstracts have been prepared on 79 papers presented at this conference. (C.H.)

**3286** AEC-tr-3661(Bk.1)(p.8-14)

BIOCHEMICAL CHANGES IN THE ORGANISM ON EXPOSURE TO IONIZING RADIATION. A. M. Kuzin. 7p.

Experimental data are reviewed which illustrate the complex picture of biochemical shifts in many systems of the cell which arise at the time of irradiation. It is only by taking into account all the interactions between altered substances and disrupted processes that the actual chain of events can be understood. A correct understanding of the initial processes provides a possible means of prophylaxis and treatment of radiation injuries. Three principles of radiation injury control or prophylaxis are outlined which are in accord with the picture presented of initial biological shifts within the irradiated organism. (C.H.)

**3287** AEC-tr-3661(Bk.1)(p.14-20)

PRIMARY PHYSICO-CHEMICAL PROCESSES IN RADIATION INJURY. B. N. Tarusov. 7p.

In the primary pathogenesis of radiation injury the reactions which take place immediately during the irradiation are considered of paramount importance. Toxic unsaturated fatty acids are formed in primary reactions and the kinetics of accumulation of these acids coincides with the progress of radiation injury. Analyses are presented of primary and secondary reactions which develop during irradiation. It is the subsiding reactions that bring about the indolatory changes which have been observed during recovery from radiation injury. The role of these reactions

increases with increased doses and dosage rates. With very large doses when death occurs during irradiation they play the decisive part, while with lesser doses the decisive role is that of the chain reaction in the lipids. (C.H.)

**3288** AEC-tr-3661(Bk.1)(p.30-9)

CHANGES OCCURRING WITHIN DIFFERENT PARTS OF THE CENTRAL NERVOUS SYSTEM AFTER EXPOSURE TO X-RAYS. M. N. Livanov. 10p.

Changes induced by a single dose of 800 to 1000 r x radiation on the spinal reflex level, subcortical formations, and cerebral cortex are compared. On the basis of the described observations it is assumed that the immediate cause of the occurrence of clinical death in radiation sickness is a profound disruption of the activity of the stem centers of the brain, and a temporary development of acute vagotonia. Disturbances in the sympathetic and parasympathetic innervation are shown to be closely associated with changes of higher vegetative centers of the hypothalamic region. (C.H.)

**3289** AEC-tr-3661(Bk.1)(p.40-50)

ELECTROPHYSIOLOGICAL STUDY OF CHANGES OCCURRING IN CONDITIONED-REFLEX ACTIVITY OF RABBITS AFTER TOTAL AND PARTIAL EXPOSURE TO X-RAYS.

Z. A. Yanson. 11p.

A study was made of changes in conditioned reflexes and of electrophysiological changes which occur in the cerebral cortex following irradiation of the entire organism, of only the head, and of only the body while the head is shielded. The experiments were conducted on rabbits in which a conditioned defense reflex to rhythmical light stimulations was developed. An unconditioned stimulus use was made of electrocutaneous stimulations of the same rhythm. A delayed defense reflex was developed. From results of the study it was concluded that total irradiation, of the head, and irradiation of the body produce different effects on the circuit-closing function of the cerebral cortex. Findings are summarized. (C.H.)

**3290** AEC-tr-3661(Bk.1)(p.51-60)

CONCERNING SOME CHANGES IN RECEPTOR-SYSTEMS UNDER THE INFLUENCE OF X-RAYS. N. S. Delitsyna. 10p.

The interrelationship of changes which develop at the periphery with the changes of nerve centers induced by radiation was studied in rabbits and cats and in patients who had received therapeutic doses of x radiation. Changes in the state of the cortical response were studied by means of electroencephography. The reaction to tactile stimulation varied. Observations are described and results discussed. (C.H.)

**3291** AEC-tr-3661(Bk.1)(p.61-8)

ALTERATION OF SPINAL CORD REFLEXES AS A RESULT OF EXPOSURE TO X-RAYS ACCORDING TO THE DATA OF ELECTROPHYSIOLOGICAL INVESTIGATIONS. Z. M. Gvozdkova. 8p.

Results are reported from a study of the changes induced by radiation in the unconditioned reflex arc as a whole, and changes within its different sections. The work was conducted on rabbits stimulated by single discharges of induction current following exposure to doses of 500, 800, or 1000 r x radiation. It was concluded that local exposure to 1000 r of x radiation results in a lowering of unconditioned motor reflexes. The disturbance of unconditioned reflex activity which occurs after whole-body exposure is the result of changes in spinal cord centers as well as in receptor apparatus. (C.H.)



**3292** AEC-tr-3661(Bk.1)(p.69-78)

EFFECT OF GAMMA-RADIATIONS OF RADIOACTIVE COBALT ON CONDITIONED AND UNCONDITIONED REFLEXES. J. A. Piontkovskii (Piontkovskiy), V. Ye. Miklashevskii (Miklashevskiy), and F. Z. Meyerson. 10p.

Disturbances in previously developed conditioned motor-alimentary reflexes were observed in rats following exposure to single doses of 650 r gamma radiation from a cobalt-60 source. Changes in conditioned reflex activity developed early and successively over a period of several months. The gravity of the disturbances depend on the region exposed. The most severe and prolonged disturbances followed irradiation of the abdominal region. Results are summarized. (C.H.)

**3293** AEC-tr-3661(Bk.1)(p.79-88)

CONDITIONED-REFLEX ACTIVITY OF DOGS ON INTRAVENOUS ADMINISTRATION OF RADIOACTIVE COBALT. P. I. Lomonos. 10p.

Results are reported from a study of conditioned reflex activity in dogs following the intravenous administration of various doses of cobalt-60. Data are included on changes observed in the blood picture. (C.H.)

**3294** AEC-tr-3661(Bk.1)(p.89-94)

THE ROLE OF THE NERVOUS APPARATUS OF THE SPLEEN IN THE PROCESS OF RESTORATION OF THE NUMBER OF LEUKOCYTES OF THE PERIPHERAL BLOOD DURING ACUTE RADIATION SICKNESS. T. K. Dzharak'yan. 6p.

A study was made of the role of neuro-reflex activity in the restoration of the number of leukocytes in the peripheral blood during acute radiation sickness. Experiments were made on rabbits and cats. Use was made of denervation of the spleen and of disruption of the conduction of nervous impulses by means of novocaine blocking. Removal of the spleen was used to provide orientational data, and in some animals the spleen was transferred under the skin before exposure to doses of x radiation ranging from 350 to 900 r. From an analysis of results it is concluded that the residual leukopenia observed during the period of recuperation from acute radiation sickness has a neurogenic origin and is due to retention of mature neutrophils in the hematopoietic system. (C.H.)

**3295** AEC-tr-3661(Bk.1)(p.95-101)

THE EFFECT OF EXTRAORDINARY STIMULATIONS OF THE NERVOUS SYSTEM ON ANIMALS RECOVERED FROM RADIATION SICKNESS. Ye. N. Antipenko, K. M. Mgebrov, and N. P. Sinyakina. 7p.

Dogs which had survived acute radiation sickness were clinically healthy after 8 months. During the 8th month following irradiation the dogs were subjected to the stress of alimentary and defense reflex encounters. Observations were made for about six weeks. Substantial deviations from the norm were observed in these dogs. These included leukopenia, a lowered blood coagulability, lowered vascular tonus, lowered blood pressure, and disturbances of thermoregulation. (C.H.)

**3296** AEC-tr-3661(Bk.1)(p.102-7)

THE QUESTION CONCERNING THE ADAPTATION REACTIONS OF THE ORGANISM DURING THE ACTION OF IONIZING RADIATION. Yu. K. Kudritskii (Kudritskiy). 6p.

Changes were observed in the duration of the flexor reflex of the shin in rabbits after exposure to single doses of x radiation. After daily exposure to doses of 0.1 to 0.05 r x radiation the changes soon disappeared. The results were interpreted as evidence of development of inurement to a constantly acting agent. The possible development of

protective adaptation reactions of the organism to changes induced by ionizing radiation are discussed. (C.H.)

**3297** AEC-tr-3661(Bk.1)(p.108-12)

THE EFFECT OF SMALL DOSES OF X-RAYS ON THE MORPHOLOGY OF THE CENTRAL NERVOUS SYSTEM OF ANIMALS. M. M. Aleksandrovskaya. 5p.

A histopathological and histochemical analysis was made of the initial and delayed changes in brain of rats following exposure to dose of 50 to 250 r x radiation. The morphological analysis indicates the presence of reversible changes in the nerve elements of the central nervous system. The mechanism of the action of ionizing radiation on the central nervous system, and the development of a secondary anoxia following irradiation of the brain are discussed. (C.H.)

**3298** AEC-tr-3661(Bk.1)(p.113-20)

MORPHOLOGICAL CHANGES IN PERIPHERAL NERVOUS SYSTEM ON EXPOSURE OF THE ORGANISM TO THE ACTION OF IONIZING RADIATION. T. N. Oleynikova. 8p.

A systematic study was made of morphological changes of the nervous system during the early period following exposure to ionizing radiations, and also in animals which had survived radiation sickness. Changes in the peripheral nervous system resulting from exposure to ionizing radiation are essentially of the same nature regardless of the kind of radiation that was utilized. As early as 30 minutes later the peripheral nervous system exhibits considerable changes which are enhanced during later periods. In some organs the changes in the nervous system are found sooner than any structural changes of the organ. In animals which perished as a result of radiation sickness considerable degenerative changes are observed which are manifested by fragmentation and disintegration of the majority of the nerve fibers. In animals which have survived the radiation sickness and which are in a state of clinical health, changes in peripheral nervous system persist up to one year. On application of P<sup>32</sup> to the skin, changes in peripheral nervous system develop first of all at the site of the application. At the same time the degenerative changes occur also in the skin not subjected to the action of the application, and also in the nerve stems of the tongue, esophagus, and stomach. Cells of the nerve centers also reveal degenerative changes on exposure to the action of ionizing radiations. (C.H.)

**3299** AEC-tr-3661(Bk.1)(p.121-5)

CONCERNING THE QUESTION OF THE "DIRECT" ACTION OF X-RAYS ON ANIMAL ORGANISM. S. Ye. Manoylov. 5p.

Reaction mechanisms involved in the biological effects of radiation on mammals are discussed. Results are summarized from studies which indicate a rapid disturbance of synthetic processes in animals irradiated with lethal doses of x rays. It is concluded that radiation induces ionization of not only the molecules of water and oxygen but also of vitally important chemical compounds the alteration of which affects the activity of the entire organism. Among such compounds are the metal-containing enzymes which take part in the process of biological oxidation, especially the iron-containing enzymes of the cytochromic system which participate in the transfer of electrons from the substance undergoing oxidation to the oxygen. Direct and indirect evidence of a disruption of the aerobic phase of biological oxidation is summarized. (C.H.)

**3300** AEC-tr-3661(Bk.1)(p.135-40)

SPECIFIC FEATURES OF THE ACTION OF FAST NEUTRONS ON THE ORGANISM OF ANIMALS. V. V. Sokolov. 6p.

A study was made of the nature of biologically toxic products found in the blood of irradiated animals and the possibility of the formation of these substances within the tissues of the organism. Biologically active substances capable of breaking down erythrocytes *in vitro* were obtained from aqueous-saline extracts of mouse organs which are hemolytically inactive under normal conditions. This extract was determined to be species specific. (C.H.)

**3301** AEC-tr-3661(Bk.1)(p.141-8)

AGE-SENSITIVITY OF ANIMALS TO TOTAL X-RAY IRRADIATION. L. A. Shparo, T. V. Fokina, and T. D. Merimova. 9p.

Young rats of all age groups were found to be more sensitive to ionizing radiation than were adult animals. Surviving young animals also recuperated more slowly from radiation injuries than did older animals. (C.H.)

**3302** AEC-tr-3661(Bk.1)(p.150-5)

SOME DATA CONCERNING THE MECHANISM OF DAMAGE TO EMBRYOS ON IRRADIATION OF GRAVID ANIMALS WITH X-RAYS. N. A. Kalinina. 6p.

Irradiation of gravid rats during the early periods of pregnancy induced disruption of implantation of embryos and death of implanted embryos. Disruption of implantation and embryogenesis was found to depend not only upon direct damage to the embryo produced by x rays but also on changes which take place in the maternal organism. (C.H.)

**3303** AEC-tr-3661(Bk.1)(p.156-63)

HEART AND SKELETAL MUSCLES DURING RADIATION SICKNESS. V. B. Zayrat'yants. 8p.

An investigation was made of the state of the myocardium and skeletal muscles during the acute stage of radiation sickness in guinea pigs. It was concluded that during radiation sickness certain morphological changes occur in the myocardium and in skeletal muscles which are followed by a disruption of the functions of these organs. (C.H.)

**3304** AEC-tr-3661(Bk.1)(p.164-8)

THE ACTION OF RADIOACTIVE RADIATIONS ON THE FUNCTIONAL STATE OF RETINA. G. G. Demirchoglyan, G. T. Adunts, and Ts. Avakyan. 6p.

Data are presented on the effects of phosphorus-32 on electric characteristics of the eye retina which reflect its functional state. It is concluded that in the clinical use of phosphorus-32 and of other radioactive isotopes it is necessary to take into account the possibility of effects of even very small amounts on the retina. (C.H.)

**3305** AEC-tr-3661(Bk.1)(p.170-7)

INVESTIGATION CONDUCTED DURING THE PERIOD OF LIFE OF THE EARLY CHANGES INDUCED IN THE ORGANISM BY IONIZING RADIATION. G. M. Frank. 8p.

Studies were made of reaction mechanisms involved in the direct and indirect effects of radiation in living tissues. Measurements were made of the free-oxygen content of the tissues in irradiated organisms. A procedure is described in which multiple electrodes were used to measure the voltage of the free oxygen in tissues. In response to the inhalation of air enriched in oxygen an immediate increase of free oxygen in the tissues was noted. Substantial disturbances in the processes of the respiratory cycle were noted following exposure to radiation. Results indicate that in irradiated organisms oxidative carbohydrate-phosphorus metabolism fails to reach the final stage. Changes in the physico-chemical state of erythrocytes following irradiation are described. It is concluded that a direct effect of radiation is manifest. (C.H.)

**3306** AEC-tr-3661(Bk.1)(p.178-84)

CHANGE IN THE METABOLISM OF NUCLEIC ACIDS

DURING RADIATION SICKNESS. Ye. A. Dikovenko. 7p.

Phosphorus-32 was used as a tracer in studies of nucleic acid metabolism during radiation sickness. A marked depression of nucleic acid metabolism was detected in spleen, bone marrow, lymphatic ganglia, thyroid gland, and intestinal mucosa. It precedes the occurrence of a number of functional and structural changes in these organs. Both direct effects and indirect effects influenced by nervous regulators were observed. (C.H.)

**3307** AEC-tr-3661(Bk.1)(p.185-90)

ELECTROPHORETIC STUDY OF THE DYNAMICS OF INCLUSION OF METHIONINE ( $S^{35}$ ) IN PROTEIN FRACTIONS OF THE BLOOD SERUM OF RABBITS ON EXPOSURE TO MASSIVE DOSES OF BETA-RADIATION. Ye. P. Smolichev. 6p.

A study was made of the dynamics of the incorporation in blood plasma of methionine labeled with sulfur-35 in rabbits under normal conditions and following exposure to massive doses of beta radiation. Following fractionation of the blood serum samples a combination of paper electrophoresis and radiometry was used to identify the protein fractions of blood serum. In order to obtain comparable results relating to the activity of different protein fractions they were expressed in specific radioactivity values. Equations used in the calculations are included. It was concluded that the rate of removal of tagged protein fractions from the blood was the result of the decomposition of proteins and input into the blood stream of newly synthesized proteins formed by utilization of sulfur-35 that had been liberated on decomposition of tissue proteins. In rabbits injured by beta-radiation the dynamics of changes in sulfur-35 activity of the blood differed sharply from those observed in control rabbits. (C.H.)

**3308** AEC-tr-3661(Bk.1)(p.191-201)

NITROGEN METABOLISM DURING EXPERIMENTAL RADIATION SICKNESS IN RATS. T. A. Fedorova. 11p.

A systematic study was made of changes in nitrogen metabolism in rats during the course of the development of radiation sickness induced by a lethal dose of x rays. Shifts in nitrogen metabolism were determined by analysis of urine for total nitrogen, urea, ammonia, amine nitrogen, creatinine, and creatine. The effects of whole-body irradiation on the digestion and assimilation of protein foods and the effect of x rays on enzymatic systems which catalyze the processes involved in renovation of tissue proteins were also investigated. Data are tabulated. A negative nitrogen balance was demonstrated soon after exposure, and the content of nitrogenous fractions in urine was altered in comparison with normal. The quantitative content of amine nitrogen in urine was reduced and a definite creatinuria was observed. Enzymatic systems apparently suffered no substantial damage. (C.H.)

**3309** AEC-tr-3661(Bk.1)(p.202-6)

THE NITROGEN METABOLISM DURING ACUTE EXPERIMENTAL RADIATION SICKNESS IN DOGS. I. V. Fedorov. 5p.

The nature of tissue breakdown during acute radiation sickness induced in dogs by whole-body exposure to x or gamma radiation was studied. Changes in nitrogen metabolism were determined by identification of metabolic end products in urine. Results indicate that in addition to the breakdown of muscle tissue and radiosensitive organs, there is also a breakdown of blood elements which have passed into the tissues, and a breakdown of individual necrotized areas of the mucosa of the small intestine. From an examination of results it is concluded that increased intensity of tissue breakdown during radiation



sickness is clearly manifest only during the acute stage that precedes death, and is essentially not directly correlated with the action of penetrating radiation but depends on a number of secondary factors. (C.H.)

**3310** AEC-tr-3661(Bk.1)(p.207-16)  
CARBOHYDRATE METABOLISM IN ANIMALS INJURED BY POLONIUM. A. Ya. Shulyatikova. 10p.

Systematic observations were made on the effects on dogs and rats of the internal administration of different doses of polonium. Emphasis was placed on effects on carbohydrate metabolism. Data were recorded on the content of sugar, lactic acid, and glycogen in the blood, and the content of glycogen in liver, muscles, spleen, and lungs. It was concluded that acute poisoning with polonium results in marked early changes in carbohydrate metabolism. Small doses of polonium induced an instability of the glycogen content of the organs and of lactic acid content of the blood. (C.H.)

**3311** AEC-tr-3661(Bk.1)(p.217-19)  
THE MUSCLE CATALASE ACTIVITY IN RATS AFFLICTED WITH RADIATION SICKNESS. V. I. Gorodyskii (Gorodyskiy) and I. V. Veselaya. 3p.

An investigation was made of catalase activity in muscle tissues of rats at various intervals following exposure to ionizing radiation. The analytical procedure is described and data are tabulated. (C.H.)

**3312** AEC-tr-3661(Bk.1)(p.220-3)  
CONCERNING THE EARLY CHANGES IN BLOOD SERUM ON TOTAL EXPOSURE TO X-RAYS WHICH ARE REVEALED BY THE SPECTROGRAPHIC METHOD. B. M. Grayevskaya and B. A. Orlov. 4p.

Data are presented which indicate ultraviolet spectrographic analysis of blood serum may provide an adequate index of early changes in protein metabolism induced by radiation. (C.H.)

**3313** AEC-tr-3661(Bk.1)(p.224-6)  
CHANGES IN SOME INDICES OF PROTEIN METABOLISM ON CHRONIC AND ACUTE ACTION OF IONIZING RADIATION. O. V. Fastuchenko and B. M. Varshavskii (Varshavskiy). 3p.

Changes in protein metabolism were observed in rabbits following both chronic and acute exposure to radiation. Following acute radiation exposure disturbances were noted within several hours. The protein metabolism was not restored to initial values for a period of several months. In chronic experiments the state of protein metabolism continued to deteriorate for several months after exposure was discontinued. (C.H.)

**3314** AEC-tr-3661(Bk.1)(p.227-35)  
SYNTHESIS AND BREAKDOWN OF BLOOD HEMOGLOBIN IN ACUTE RADIATION SYNDROME. A. P. Belousov, M. G. Shitikova, and L. L. Shepshelevich. 9p.

Data are presented from a study of the dynamics of synthesis and breakdown of blood hemoglobin during the development of radiation sickness. Whole-body irradiation of dogs and rabbits was followed by hemolysis of erythrocytes and breakdown of hemoglobin. The periodic nature of bilirubin excretion during radiation sickness was interpreted as indicating a phasal breakdown of erythrocytes. Irradiation of dogs with sublethal doses depressed hemopoiesis and synthesis of blood hemoglobin. It was concluded that the anemia of radiation sickness is due to increased hemolysis of erythrocytes, a depression of erythropoiesis and blood loss due to the development of hemorrhagic diathesis. Early transfusions of freshly citrated blood had a beneficial effect on general condition of the animal. Trans-

fusions of protein solution decreased hemolysis of erythrocytes and reduced hemorrhagic diathesis. (C.H.)

**3315** AEC-tr-3661(Bk.1)(p.236-9)  
CHARACTERIZATION OF ERYTHROPOIESIS DURING RADIATION SICKNESS ON THE BASIS OF THE RATE OF RENOVATION OF IRON AND SULFUR COMPONENTS OF THE HEMOGLOBIN OF ERYTHROCYTES. L. A. Klyucharev. 4p.

Iron-59 and sulfur-35 were used as tracers in a quantitative evaluation of changes in hemopoiesis induced by radiation injury in rabbits. The rate of renovation of the iron and sulfur components of hemoglobin in peripheral blood was determined. Results indicate a disturbance of metabolism in bone marrow of irradiated animals. (C.H.)

**3316** AEC-tr-3661(Bk.1)(p.240-51)  
CHANGES IN COMPOSITION AND METABOLIC PROCESSES OF BONE MARROW ON EXPOSURE TO IONIZING RADIATION. R. Ye. Libinzon. 11p.

A single whole-body exposure to gamma radiation induced sharp changes in the chemical composition and metabolic processes of bone marrow in rabbits. Data are included on changes produced following exposure to 25, 50, 100, and 1000 r. Possible mechanisms involved in radiation injury to bone marrow are discussed. (C.H.)

**3317** AEC-tr-3661(Bk.1)(p.252-9)  
EXPERIMENTAL LEUKOSES IN DOGS ON SYSTEMATIC EXPOSURE TO SMALL DOSES OF X-RAYS. M. S. Lapteva-Popova. 8p.

Daily exposure of dogs to small doses of x rays resulted in the development of leukoses after 2.5 to 5 years. Changes were evident in both peripheral blood and bone marrow. (C.H.)

**3318** AEC-tr-3661(Bk.1)(p.260-9)  
REACTION-CHANGES DEVELOPING IN THE ENDOTHELIUM OF LARGE BLOOD VESSELS AFTER IRRADIATION WITH X-RAYS. N. A. Shevchenko. 10p.

The reaction of rabbits to radiation was manifest by changes in the large arteries and veins which are particularly evident in the endothelium. Changes in endothelium were found to develop during the early stages of radiation sickness and to have a protracted course. Changes were also found in the endothelium of small blood vessels. (C.H.)

**3319** AEC-tr-3661(Bk.1)(p.270-2)  
CHANGES IN RESPIRATORY PROPERTIES OF BLOOD IN ACUTE RADIATION SICKNESS. V. V. Merenov. 3p.

During the early stages of radiation sickness in dogs no pronounced disturbance was observed in respiratory properties of the blood. During the last stages a hypoxia of anemic origin was observed. Compensatory mechanisms breakdown prior to death and a severe hypoxia was noted. (C.H.)

**3320** AEC-tr-3661(Bk.1)(p.273-7)  
HISTOPATHOLOGICAL CHANGES IN THE INTESTINE DURING ACUTE RADIATION SICKNESS. V. M. Chernykh. 5p.

Morphological changes of the intestine during acute radiation sickness were studied in dogs and rats. Results are described. (C.H.)

**3321** AEC-tr-3661(Bk.2)(p.279-84)  
STRUCTURAL CHANGES IN TISSUES OF IRRADIATED ANIMALS. A. I. Polivoda. 6p.

A procedure is described which was developed to study the kinetics of the action of extracts of liver of mice, which had been irradiated, on surviving muscle tissue. Electronmicrograms were prepared of the centrifugate of aqueous extracts of liver homogenates. The dimensions were

measured of filaments observed in the lipid fraction of the liver. It was concluded that submicroscopic processes develop in the lipid phase of the liver tissue which are characterized by polymerization, and that radiation injury consists of a molecular structure process based on a mechanism analogous to the mechanism of chain reactions. This process undergoes regular development during the latent period of radiation sickness and has as a final result the disturbance of elemental vital processes, the clinical manifestation of which is radiation sickness. (C.H.)

**3322** AEC-tr-3661(Bk.2)(p.285-9)  
SOME DATA CONCERNING SPECIFIC FEATURES OF INFECTIOUS PROCESSES AND IMMUNOLOGICAL REACTIVITY IN IRRADIATED ANIMALS. N. N. Klemparskaya. 5p.

Results are reported from a study of infectious processes and immunological reactivity in irradiated animals. Investigations demonstrated there is an enhancement of the virulence of the bacteria present within the irradiated organism, a lowering of the capability to limit proliferation of bacteria into the tissues, and a disturbance of immunological reactivity. The similarity of the phenomena produced on experimental injection of suspensions of homologous tissues in guinea pigs and of the symptoms of radiation sickness led to the conclusion that autosensitization plays an important part in the pathogenesis of radiation sickness and in immunobiological reactivity in irradiated organisms. (C.H.)

**3323** AEC-tr-3661(Bk.2)(p.290-7)  
THE COURSE OF EXPERIMENTAL INFLUENZA INFECTION IN WHITE MICE AND RATS UNDER CONDITIONS OF TOTAL IRRADIATION WITH X-RAYS. A. A. Smorodintsev. 8p.

Irradiation of white mice and rats with x rays increases considerably their susceptibility to infection with influenza virus. Mortality of animals inoculated with influenza virus depends on magnitude of the dose and on the length of time which separates inoculation from irradiation. Reproduction of virus in the lungs of irradiated animals exceeds by many times the reproduction values in the control animals and depends upon the dose of prior irradiation. Total irradiation of white mice and rats with x rays results in a prolonged survival of influenza virus in the lungs of these animals. A prior irradiation of the animals in combination with inoculation of the animals with low-pathogenicity strains of influenza virus results in the development of macroscopically visible pneumonic foci which involve one or several lobes of the lung, which is never observed in non-irradiated control animals. A prior irradiation of the animals with doses of 100 to 150 r induces a suppression of the production of specific virus-neutralizing antibodies, the intensity of which depends on the dose of irradiation. Investigation of the amount of thermolabile substances in the serum of irradiated mice has shown a certain increase of this amount during all periods, in comparison with the controls. (auth)

**3324** AEC-tr-3661(Bk.2)(p.298-303)  
PROLIFERATION OF MICROBES IN TISSUES OF ANIMALS IRRADIATED WITH X-RAYS. V. F. Sosova. 6p.

Intensive proliferation of bacteria in the tissues of irradiated animals during the period of acute radiation sickness was demonstrated. The inflammation reaction induced by staphylococcus was compared with that produced by benzene. (C.H.)

**3325** AEC-tr-3361(Bk.2)(p.304-9)  
VARIABILITY OF MICROBES IN THE IRRADIATED ORGANISM. G. A. Chekatilo. 6p.

Increase in virulence of bacteria in irradiated guinea pigs was found to be correlated with the severity of radiation sickness. (C.H.)

**3326** AEC-tr-3661(Bk.2)(p.310-17)  
CHANGES IN SOME IMMUNOLOGICAL REACTIONS IN ANIMALS DURING RADIATION SICKNESS INDUCED BY POLONIUM. B. B. Moroz and V. V. Vasil'yevskaya. 8p.

Results are reported from a study of the effects of injected polonium of various doses on antibody production, immunological state, and phagocytic activity of reticulo-endothelium of liver in rabbits. Results indicate that radiation disrupts immunological reactions. Possible mechanisms involved are discussed. (C.H.)

**3327** AEC-tr-3661(Bk.2)(p.318-24)  
THE COURSE OF INFLAMMATION DURING ACUTE RADIATION SICKNESS. V. V. Shikhodyrov. 7p.

A study was made of the course of inflammatory reactions during acute radiation sickness in rats. Results showed a direct correlation between the nature of the inflammatory reaction and the magnitude of the dose of radiation energy. Inflammations produced in cutaneous tissues by injected celloidin are compared in irradiated and non-irradiated rats. (C.H.)

**3328** AEC-tr-3661(Bk.2)(p.325-33)  
EFFECT OF INFLAMMATION ON PHAGOCYTIC REACTION OF RETICULOENDOTHELIAL SYSTEMS ON POLONIUM-INDUCED INJURY TO ANIMALS. A. I. Chuchukalo. 9p.

A study was made of the effect of polonium on the phagocytic activities of the reticulo-endothelial system in mice. The significance of inflammation on phagocytic activity during the development of radiation injury was also studied. (C.H.)

**3329** AEC-tr-3661(Bk.2)(p.334-7)  
THE EFFECT OF TOTAL IRRADIATION WITH X-RAYS ON PHAGOCYTIC FUNCTION OF GRANULOCYTES. V. V. Demidas. 4p.

Results are presented graphically and discussed on the effects of whole-body irradiation of guinea pigs with LD<sub>50</sub> doses of x radiation on phagocytic activity of leukocytes in the peripheral blood. (C.H.)

**3330** AEC-tr-3661(Bk.2)(p.338-43)  
ANTIGENIC CHARACTERISTICS OF TISSUES OF IRRADIATED ANIMAL ORGANISM. T. V. Petrov and L. I. Il'ina. 6p.

A study was made of the antigenic properties of tissues of irradiated rats. Tissues of irradiated rats were found to possess antigenic differences which distinguished them from normal. It was concluded that the state of sensitization of irradiated organisms is induced by intrinsic proteins. Reaction mechanisms involved in the sensitization of irradiated organisms are discussed. (C.H.)

**3331** AEC-tr-3661(Bk.2)(p.344-6)  
LOWERING OF SENSITIVITY OF ANIMALS TO EXPOSURE TO LETHAL DOSES OF X-RAYS FOLLOWING THEIR PRIOR IRRADIATION WITH NON-LETHAL DOSES. B. M. Grayevskaya and R. Ya. Keylina. 3p.

Previous irradiation with non-lethal doses of x radiation enhanced the resistance of rats and dogs to subsequent exposure to lethal doses of ionizing radiation. (C.H.)

**3332** AEC-tr-3661(Bk.2)(p.347-50)  
CONCERNING THE EFFECT OF TOTAL IRRADIATION WITH X-RAYS ON THE COURSE OF PARATYPHOID IN MONKEYS. L. A. Yakovleva, B. A. Lapin, S. M. Pekerman, M. I. Novikova, and S. A. Avetisova. 4p.

A study was made of the course of paratyphoid-B in



monkeys previously exposed to 300 r x radiation. Experiments were also carried out to check the effects of ionizing radiation on immunity resulting from exposure to paratyphoid-B. (C.H.)

**3333** AEC-tr-3661(Bk.2)(p.351-4)

SOME PROBLEMS PERTAINING TO DISTRIBUTION AND ABSORPTION OF RADIOACTIVE RUTHENIUM, CESIUM, STRONTIUM, AND COBALT UNDER THE CONDITIONS OF A CHRONIC EXPERIMENT. E. B. Kurlyandskaya. 4p.

Changes are recorded which were observed in rabbits over a period of eleven months to 2.5 years during the oral administration of cesium-134, strontium-89, ruthenium-106, and cobalt-60. Analysis of all the data made it possible to ascertain common features in the reaction of the blood to all the isotopes under study. (C.H.)

**3334** AEC-tr-3661(Bk.2)(p.355-61)

CHANGES IN FUNCTIONAL ACTIVITY OF THE KIDNEYS IN DOGS INJURED BY POLONIUM. Z. I. Poluboyarinova. 7p.

Results are reported from a study of kidney function in dogs injured by polonium. After background studies were made of renal function, polonium was injected subcutaneously. Urine was collected for several days and determinations were made of specific gravity, reaction, color, content of protein, chlorides, and urea. Microscopic examinations were made of the sediment. Administration of dyes made it possible to detect disturbances in the secretory function of the tubuli. Changes in renal function were phasal. Data are tabulated and results discussed. (C.H.)

**3335** AEC-tr-3661(Bk.2)(p.362-6)

CHANGES IN LUNGS AND OTHER ORGANS ON INTRATRACHEAL ADMINISTRATION OF RADIOACTIVE SODIUM CHLORIDE AND CHROMIUM PHOSPHATE. T. A. Kochetkova and G. A. Avrunina. 5p.

Histological investigations were made of the lungs and other internal organs of rats following the intratracheal administration of sodium-42 in the form of a solution of sodium chloride and phosphorus-32 administered as an insoluble chromium phosphate. Injury to the walls of blood vessels in the lungs and to the epithelium of bronchial mucosa was observed. Data are tabulated and microphotographs of lung tissue are included. (C.H.)

**3336** AEC-tr-3661(Bk.2)(p.367-73)

STUDY OF THE DEVELOPMENT IN ANIMALS OF BONE TUMORS ARISING UNDER THE INFLUENCE OF RADIOACTIVE SUBSTANCES. N. A. Krayevskii (Krayevskiy) and N. N. Litvinov. 7p.

A study was made of bone tissue changes in 100 rats into which strontium-90 had been introduced intraperitoneally at a dose of 0.4  $\mu\text{C/g}$  of body weight. Changes in bone tissue are most pronounced in metaphyses of long tubular bones. They consist of a progressive disturbance of the processes of osteogenesis, with the formation of steadily more immature and primitive bone structures. These changes of a dysplastic nature terminate in a number of cases in malignant growth. At first, in the course thereof, during the 2nd and 3rd month following administration of radioactive strontium, disturbance of the processes of osteogenesis consist of a production of atypical, imperfect structures, mostly of osseous, fibrous, and amorphous nature. Later on, during the 4th month, in addition to atypical osseous, fibrous, and amorphous structures, there are formed extensive accumulations of osteogenic tissue consisting primarily of undifferentiated cell elements. During the 5th month a further distortion of processes of osteogenesis is observed. Extensive tissular proliferates are formed which consist of atypical osteogenic cells, and

undergo propagation along the bone marrow cavity. By the end of the 5th and the beginning of the 6th month of the injury, there are formed among the growths of atypical osteogenic tissue, areas which have the appearance of tumors. They increase rapidly in size, fill the bone marrow cavity and extend outside of the bone. (auth)

**3337** AEC-tr-3661(Bk.2)(p.374-81)

ACCUMULATION OF RADIOACTIVE STRONTIUM AND CESIUM IN THE BODY OF EMBRYOS UNDER CONDITIONS OF CHRONIC ADMINISTRATION OF THESE ISOTOPES TO FEMALES. A. A. Rubanovskaya. 8p.

Radioactive strontium which has become affixed within the skeleton of the female, is mobilized in a relatively small amount during the pregnancy, and therefore on prolonged intake of small amounts thereof into the organism of the female prior to and during the period of pregnancy, accumulation within the body of the fetus depends essentially upon the amount of isotope intake by the female during pregnancy. Administration of  $\text{Sr}^{90}$  and  $\text{Cs}^{134}$  to nursing females results in a sharp increase of their content in the organism of the young. Only on a complete transition to self-sustaining feeding does a decrease in the content of  $\text{Sr}^{90}$  and  $\text{Cs}^{134}$  begin to take place in the body of the young. (auth)

**3338** AEC-tr-3661(Bk.2)(p.382-7)

MORPHOLOGICAL CHANGES IN THE KIDNEYS DURING ACUTE RADIATION SICKNESS INDUCED BY RADIOACTIVE PHOSPHORUS. E. I. Shcherban' and Z. A. Vlasova. 6p.

Morphological changes are described which were observed in the kidneys following the administration of phosphorus-32 to rabbits and mice. Histological studies of the kidneys revealed signs of circulatory disturbances one hour after administration of the phosphorus-32 and reaching a maximum at the time of death of the animals. Autoradiograms showed the pattern of deposition of phosphorus-32 in the kidneys. (C.H.)

**3339** AEC-tr-3661(Bk.2)(p.388-96)

PATHOLOGICO-ANATOMIC CHARACTERISTICS OF PULMONARY COMPLICATIONS OF EXPERIMENTAL ACUTE RADIATION SICKNESS. N. I. Mudretsov. 9p.

A statistical study was made of pulmonary complications associated with radiation sickness in dogs and rats. Results are tabulated from bacteriological investigation of the lungs of animals which died. (C.H.)

**3340** AEC-tr-3661(Bk.2)(p.397-405)

CONTRIBUTION TO THE ANALYSIS OF TOXIC AND RECUPERATIVE CHANGES IN THE METABOLISM OF PHOSPHORUS-CONTAINING COMPOUNDS UNDER THE INFLUENCE OF SOME INDUSTRIAL POISONS AND ANTIDOTES. T. A. Prokopenko. 9p.

Results are reported from a study of the effects of fluoride, vanadate, and manganese chloride, and of substances which counteract their toxic action, on the metabolism of phosphorus-containing compounds labeled with phosphorus-32. Toxic and recuperative changes in liver metabolism of phosphorus compounds were measured following the poisoning of rats with sub-lethal doses of fluoride, vanadate, or manganese chloride. Data are tabulated on the distribution of phosphorus-32 in different fractions of phosphorus-containing compounds of the liver at various times after administration of the poisons. (C.H.)

**3341** AEC-tr-3661(Bk.2)(p.406-11)

THE EFFECT OF SILICIC ACID ON BONDING OF RADIOACTIVE METABOLITES BY TISSUE PROTEINS. T. I. Kazantseva. 6p.

A study was made of reaction mechanisms involved in

the bonding of methionine to tissue proteins by silicic acid. Results are compared with those obtained with urea. The investigations were conducted on isolated liver and kidney tissues of rats and mice. The methionine was labeled with sulfur-35. Data are included on the bonding of methionine by serum proteins of healthy people, silicosis patients, and persons exposed to quartz dust. (C.H.)

**3342** AEC-tr-3661(Bk.2)(p.412-15)

THE USE OF ISOTOPES IN THE STUDY OF SPECIFIC FEATURES OF METABOLISM OF MALIGNANT NEOPLASMS. N. V. Yel'tsina. 4p.

Phosphorus-32 was used in studies on the dynamics of phosphorylation during aerobic and anaerobic metabolism. Phosphorus-32 was used in experiments on Ehrlich's ascitic carcinoma cells conducted in a Warburg's apparatus. Intensity of phosphorylation was measured on the basis of the rate of inclusion of phosphorus-32 in the acid-insoluble organic fraction. It was concluded that malignant neoplasms possess an enhanced capability of utilizing carbohydrates, as compared with normal tissues. (C.H.)

**3343** AEC-tr-3661(Bk.2)(p.416-20)

THE PARTICIPATION OF SOME COMPONENTS OF THE CELL IN THE SYNTHESIS OF PROTEIN IN TUMORS AND IN NORMAL ORGANS ACCORDING TO DATA ON INCLUSION OF TAGGED AMINO ACIDS. I. B. Zbarskii (Zbarskiy) and K. A. Perevoshchikova. 5p.

Methionine labeled with sulfur-35 and glycine labeled with carbon-14 were used in studies of protein synthesis in integral tissue, cell nuclei, and fractions of homogenates of rat sarcoma, mouse hepatoma, and normal organs of these animals. Data are tabulated and results are discussed. (C.H.)

**3344** AEC-tr-3661(Bk.2)(p.421-30)

RATE OF RENOVATION OF PROTEINS OF BRAIN AND LIVER IN CONVULSIVE STATE. V. I. Rozengart and M. N. Maslova. 10p.

Convulsions, induced by corazol, result in decreased rate of incorporation of methionine labeled with sulfur-35 in the proteins of brain and liver of rabbits. These convulsions do not affect the total sulfur content of the proteins of brain, and liver, in rabbits. Inhibition of the function of the central nervous system, induced by difacil, does not alter the rate of renovation of the proteins of brain and liver, in rabbits. Poisoning of rats with fosfakol does not affect the rate of renovation of proteins of brain, liver, and kidneys. Decrease in the rate of renovation of proteins of brain and liver during convulsions, in rabbits, is apparently due to increase of specific brain metabolism and decreased intensity of anabolic metabolism which is associated therewith. (auth)

**3345** AEC-tr-3661(Bk.2)(p.431-40)

THE USE OF TAGGED ATOMS IN THE STUDY OF BARRIER FUNCTIONS OF THE ORGANISM. N. N. Zayko, N. I. Korkhova, T. M. Tupikova, N. F. Shaposhnikova, S. M. Mints, and I. P. Popov. 10p.

Results are summarized from over 100 experiments in which phosphorus-32 and iodine-131 were used to study the characteristics of barrier functions in various parts of the body in rabbits and cats. The rate of penetration of the radioactive materials was measured for the hematoencephalic barrier, or blood-brain barrier, the placental barrier, and the hemato-ophthalmic barrier in the eye. Blood serum levels are compared with those of cerebrospinal fluid, ear lymph, aqueous humor, fetal blood, and synovial fluid. The role of the nervous system in the regulation of the barriers, and the effects of stimulation of dif-

ferent nerves on penetrability of the barriers was also studied. (C.H.)

**3346** AEC-tr-3661(Bk.2)(p.441-9)

STUDY OF CAPILLARY PERMEABILITY AND CAPILLARY CIRCULATION BY MEANS OF ARTIFICIAL RADIOACTIVE ISOTOPES. I. A. Oyvin. 9p.

Phosphorus-32, iodine-131, and sulfur-35 were used in studies of capillary permeability. The rate of transfer through capillary membranes was found to depend upon the nature of the substance, the amount of functioning capillaries, the degree of their dilation, and blood flow velocity in the capillaries. Physiological conditions regulating capillary permeability were also studied. Data are tabulated from studies on dogs and rabbits. (C.H.)

**3347** AEC-tr-3661(Bk.2)(p.450-3)

THE SIGNIFICANCE OF DETERMINATIONS OF THE TOTAL AMOUNT OF BLOOD IN STUDIES OF THE MECHANISM OF REGULATION OF BLOOD FORMATION. Ya. G. Uzhanski (Uzhanskiy). 4p.

Results are reported from studies using phosphorus-32 to determine blood volume and blood formation. It was concluded that the regeneration of erythrocytes involves an activation phase and a phase during which new erythrocytes are formed. Hypoxia was found to stimulate blood formation while hyperoxia inhibited it in rabbits. Artificially induced sleep was found to inhibit blood regeneration. The relationship of hypertonia and anemia was also studied and results are reported. (C.H.)

**3348** AEC-tr-3661(Bk.2)(p.454-62)

STUDY OF METABOLISM OF MACROERGIC PHOSPHORUS COMPOUNDS IN THE HEART BY MEANS OF RADIOACTIVE PHOSPHORUS. M. Ye. Rayskina. 9p.

Phosphorus-32 was employed in studies on the metabolism of phosphorus compounds in the heart muscle of dogs. Particular emphasis was placed on the metabolism of adenosine triphosphoric acid and phosphocreatine, and their influence on the mechanism involved in the alteration of the force of the heart's contractions. Chemical mechanisms involved in changes in the force of the heart's contractions during stimulation of the vagus and cardiac-stimulating nerves were also studied. (C.H.)

**3349** AEC-tr-3661(Bk.2)(p.463-77)

SOME REGULARITIES OF THE PROCESS OF BONDING OF TAGGED AMINO ACIDS BY PROTEINS. S. E. Shnol'. 15p.

Studies of bonding of amino acids by protein *in vitro* were made in simple, structureless systems such as white of eggs, serum albumin, and myosin. Methionine labeled with sulfur-35, glycine labeled with carbon-14, and tyrosine labeled with carbon-14 were used in the studies. Data are presented graphically and are discussed. (C.H.)

**3350** AEC-tr-3661(Bk.2)(p.478-82)

DEPOSITION OF INORGANIC PHOSPHATE IN BONE TISSUE DURING DIFFERENT STAGES OF ADAPTATION OF BONE AUTOTRANSPLANT. G. P. Krasovskaya. 5p.

Data are reported from tracer studies using phosphorus-32 on the deposition of inorganic phosphate in bone tissue during different stages of adaptation to bone autotransplants. Findings are compared with morphological changes observed in the bone transplants undergoing adaptation and in the surrounding tissues. (C.H.)

**3351** AEC-tr-3661(Bk.2)(p.483-90)

THE DISTRIBUTION OF DIFFERENT TAGGED COMPOUNDS WITHIN THE ORGANISM, THEIR PENETRATION FROM MOTHER TO FETUS AND EXCRETION IN MATERNAL MILK. M. I. Usanova. 8p.



Caffeine labeled with carbon-14 and streptocide, penicillin, and thiamine labeled with sulfur-35 were used to study the tissue distribution and dynamics of penetration from mother to fetus in rats. It was found that caffeine, streptocide, thiamine, and penicillin show differences in distribution within the tissues of the mother, and penetrate from mother to fetus at different rates and in different amounts. Caffeine was present in all fetal tissues within ten minutes of administration to the mother and reached a maximum within 2 to 3 hours. The content of caffeine in the placenta was somewhat higher than in the fetus. Following administration of penicillin to the mother, only a very small portion was found to penetrate to the fetus. Streptocide and thiamine both penetrated readily from the mother to the fetus. All four compounds were excreted with milk when administered during the period of lactation. (C.H.)

**3352** AEC-tr-3661(Bk.2)(p.491-7)  
INCLUSION OF S<sup>35</sup>-METHIONINE IN THE PROTEINS OF MUSCLES AND SKIN OF RABBITS AS A RESULT OF APPLICATION OF TOURNIQUET AND UNDER SOME OTHER CONDITIONS. I. Ye. Malakhov. 7p.

Changes in tissues of extremities to which a tourniquet has been applied for the control of hemorrhage were investigated. Methionine labeled with sulfur-35 was used to study intermediate metabolism in the legs of rabbits following disruption of the physiological state by application of a tourniquet. Decreases in the inclusion of methionine in muscle proteins were noted following application of the tourniquet. It was concluded this was due to changes in the tissue proteins as a result of disturbances in metabolism as a whole. It was noted that liver proteins were more active after removal of the tourniquet than were the proteins of this organ in healthy animals. (C.H.)

**3353** AEC-tr-3661(Bk.2)(p.498-507)  
THE USE OF RADIOACTIVE PHOSPHORUS AND CARBON IN THE STUDY OF THE EFFECT OF VITAMIN C ON TRANSFORMATIONS OF NUCLEIC ACIDS WITHIN THE CELLS OF ANIMAL ORGANISM. B. I. Gol'dshteyn, V. V. Gerasimova, and L. G. Kondrat'yeva. 10p.

Phosphorus-32 and carbon-14 were used as tracers in a study of the mechanisms involved in the conversion of ribonucleic acid of the cell to desoxyribonucleic acid of cell nucleus, and the role of ascorbic acid in the process. Data are tabulated from studies of guinea pigs and results are discussed. (C.H.)

**3354** AEC-tr-3661(Bk.2)(p.508-14)  
METABOLISM OF ERYTHROCYTES ON THE ACTION THEREON OF SILICATES AND AMINO ACIDS. V. A. Shcherbatskaya. 7p.

A study of the metabolism of erythrocytes after subjecting them to the action of silicates indicates that these compounds induce profound disturbances of metabolic processes in erythrocytes, both upon their exposure to the action of silicates within the organism and outside of it. Disturbances in important metabolic reactions (phosphorylation reactions within erythrocytes) during development of silicotic process are reversible and can be recuperated by means of an addition of cysteine to the blood. A number of other amino acids, in particular glycol, can safeguard the erythrocytes only against the hemolytic action of silicates. This supports the assumption of distinct mechanism of action of different amino acids on the metabolism of erythrocytes. The capability of glycol and other amino acids to safeguard erythrocytes against the hemolytic action of silicates is of great practical importance in the prolongation of the length of time during which preserved blood can be kept in storage. (auth)

**3355** AEC-tr-3661(Bk.2)(p.515-18)  
DISTRIBUTION OF BLOOD DURING TRAUMATIC SHOCK. T. M. Mel'nikov. 4p.

Erythrocytes labeled with phosphorus-32 were used to study the distribution of blood during traumatic shock in rabbits. Data are tabulated. (C.H.)

**3356** AEC-tr-3661(Bk.2)(p.519-27)  
THE USE OF RADIOACTIVE TRACERS IN THE STUDY OF ABSORPTION AND DISTRIBUTION OF VITAMIN B<sub>1</sub>. Yu. I. Kolesnichemko. 9p.

Sulfur-35 was used as a tracer in studies of the absorption and distribution of vitamin B<sub>1</sub> in rats under normal conditions and under conditions involving the action of various pharmacological agents on the central nervous system. (C.H.)

**3357** AEC-tr-3661(Bk.2)(p.528-33)  
UTILIZATION OF THE METHOD OF TAGGED ATOMS IN THE STUDY OF TROPHIC DISTURBANCES OF MUCOUS COAT OF THE STOMACH. I. S. Zavodskaya. 6p.

The rate of inclusion of methionine labeled with sulfur-35 in proteins of gastric mucosa was used as a criteria in a study of the effects of medicinal agents on tissue metabolism of the mucous coat of the stomach. The experiments were conducted on guinea pigs. The effects of luminal, hexonium, and pentamine were studied. Data are tabulated. (C.H.)

**3358** AEC-tr-3661(Bk.2)(p.534-41)  
OXIDATION OF HYDROGEN SULFIDE IN THE ORGANISM. A. I. Gunina. 8p.

Results are reported from a study of the tissue distribution of sodium sulfide labeled with sulfur-35 in dogs at various times following intravenous administration. The distribution and oxidation of hydrogen sulfide in the rats were determined. (C.H.)

**3359** AEC-tr-3661(Bk.2)(p.542-7)  
STUDY OF THE METABOLISM OF RADIOACTIVE THIAMINE IN ANIMAL ORGANISM. A. Ya. Rozanov, N. P. Bulatskii (Bulatskiy), D. A. Tsuverskulov, and L. V. Shcherbakova. 6p.

Thiamine labeled with sulfur-35 was used to study the metabolism of vitamin B<sub>1</sub> in rats. The decomposition of thiamine to non-vitamin products was of particular interest. (C.H.)

**3360** AEC-tr-3661(Bk.2)(p.548-50)  
PERMEABILITY OF ERYTHROCYTES TO PHOSPHATES UNDER NORMAL CONDITIONS AND IN BURNS. V. I. Baydak. 3p.

Results are reported from studies in which phosphorus-32 was used to study the rate of interchange of phosphates between erythrocytes and plasma in healthy dogs and in cases of burns. Data are tabulated. The content of phosphorus-32 in the erythrocytes was found to be considerably reduced following third degree thermal burns. (C.H.)

**3361** AEC-tr-3661(Bk.2)(p.551-4)  
EFFECT OF THE COMPOSITION OF PRESERVANT SOLUTIONS ON THE LEVEL OF CARBOHYDRATE-PHOSPHORUS METABOLISM IN PRESERVED BLOOD. S. Ye. Tukachinskii (Tukachinskiy). 4p.

Phosphorus-32 was used in a study of the effects of five different blood preservatives on metabolism of carbohydrates and phosphorus in blood. (C.H.)

**3362** AEC-tr-3661(Bk.2)(p.555-6)  
UTILIZATION OF RADIOACTIVE ISOTOPES IN THE DEVELOPMENT OF THE PROBLEM OF IONO-GALVANIZATION. A. N. Obrosof, I. A. Abrikosov, and E. D. Tykochiskaya. 2p.



Iodine-131, bromine-82, phosphorus-32, and caffeine labeled with carbon-14 were administered to rabbits and their effects on the functional state of the central nervous system were investigated. Results were used in estimating the uptake of the therapeutic agents by the animals. A feature of Iono-galvanization is the formation of a stable deposit of ions at the region of skin deposition from which ions are gradually transferred by the blood stream to remote parts of the organism. If the therapeutic agents are organotropic, this property is retained on their administration by means of a current. Novocain anesthesia was found to increase the accumulation of the agent in the skin deposit and limit its transfer to other parts of the organism. (C.H.)

### 3363 NP-tr-315

THE MEASUREMENT OF NATURAL RADIOACTIVITY IN HUMAN ORGANS. L. G. Shakhidzhanyan, D. G. Fleishman, V. V. Glazunov, V. G. Leont'ev, and V. P. Nesterov. Translated from *Doklady Akad. Nauk S.S.S.R.* **125**, 208-9 (1959). 5p. JCL or LC.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, as abstract No. 11569.

### 3364 UCRL-Trans-496

ISOTOPIC COMPOSITION OF THE OXYGEN EVOLVED IN PHOTOSYNTHESIS. A. P. Vinogradov, V. M. Kuturina (Kuturina), M. V. Ulubekova, and I. K. Zadorozhnyi (Zadorozhnyi). Translated from *Doklady Akad. Nauk S.S.S.R.* **125**, 1151-3 (1959). 6p. JCL or LC.

The isotopic composition of the oxygen of fresh water photosynthesis was measured in experiments with *Elodea canadensis*. Comparison was made with the isotopic composition of photosynthetic oxygen of marine phytoplankton obtained in experiments with diatoms. Data are tabulated. (C.H.)

### 3365

INVESTIGATIONS ON THE EXCRETORY INTENSIFICATION OF INCORPORATED RADIOSTRONTIUM. H. Kriegel and H. Melchinger (Heiligenberg-Institut, Ger.). *Atompraxis* **5**, 425-30 (1959) Oct.-Nov. (In German)

The influencing of radiostrontium deposits in the organism after administration of various chelating agents is examined. Prophylactic, simultaneous, and subsequent (up to 6 hr) i.v. or i.p. application of radium 1,2-dihydroxybenzol-3,5-disulfonic acid (Tiron) produced a decrease of  $\text{Sr}^{90}$  content in the skeleton and parenchymatous organs in comparison with the controls. Effectiveness in regard to the skeleton is but slightly satisfactory, but is relatively high in the liver and kidneys; here i.p. injection proved to be more advantageous. A noteworthy influencing of  $\text{Sr}^{90}$  deposits in the skeleton was attained with diamond blue BL. Na rhodizonate had no effect. (auth)

### 3366

THE USE OF LARGE AMOUNTS OF RADIOACTIVE SULFUR IN PATIENTS WITH ADVANCED CHONDROSARCOMAS. II. DISTRIBUTION AND TISSUE IRRADIATION. Raymond G. Gottschalk, Louis K. Alpert, and Phyllis O. Miller (George Washington Univ., Washington, D. C. and Veterans Administration Center, Martinsburg, W. Va.). *Cancer Research* **19**, 1078-85 (1959) Nov.

In the course of attempts of treatment of advanced cases of chondrosarcoma by injections of large amounts of radio-sulfate, tissue samples were obtained at intervals and analyzed for isotope content. The average concentration of  $\text{S}^{35}$  was greater in the chondrosarcomas than in any other tissue analyzed. The results demonstrated the long retention of  $\text{S}^{35}$  in the tumors. A method was developed for calculation of the irradiation doses after multiple injections

of  $\text{S}^{35}$ . The effective half life of  $\text{S}^{35}$  in the chondrosarcomas was estimated to vary between 26.1 and 41.8 days. The average cumulative irradiation delivered to all parts of the tumors was calculated to be 1772 to 3661 rad. The portions of the neoplasms that were growing during the periods of isotope injections had higher than average uptake and received cumulative doses in excess of 4000 rad. Normal tissues received smaller doses of radiation. The blood received cumulative doses of 40 to 68 rad. The significance of these relatively favorable differential ratios of irradiation for the treatment of advanced chondrosarcomas was discussed. (auth)

### 3367

RATE OF INCORPORATION OF  $\text{Fe}^{59}$  INTO THE NUCLEI AND CYTOPLASM OF NORMAL AND TUMOR TISSUE. F. A. Kruchakova (Ukrainian Research Inst. of Nutrition, Kiev). *I.C.R.S. Med. Repts.*, No. 3, 14 (1959) July.

Normal rats and rats with transplanted sarcoma of Tarashchanskaya were used. The extent of incorporation of  $\text{Fe}^{59}$  (as  $\text{FeCl}_3$ , or as  $\text{Fe}^{59}$ -ascorbate, or as  $\text{Fe}^{59}$ -tartrate) into the nucleoproteins of the nuclei of normal and tumor tissue indicated that the poor incorporation of  $\text{Fe}^{59}$  as  $\text{FeCl}_3$  into tumor tissue is due to poor absorption of  $\text{FeCl}_3$ . In experiments *in vitro* no difference in the capacity to bind Fe in normal or neoplastic tissue was observed; in experiments *in vivo*, however, the incorporation of Fe into nuclei of tumors was higher than into the total tumor tissue. The absorption of Fe from  $\text{Fe}^{59}$ -ascorbate or  $\text{Fe}^{59}$ -tartrate into the nucleus and entire tumor tissue was markedly greater than from  $\text{FeCl}_3$ - $\text{Fe}^{59}$ . Experiments, in which  $\text{P}^{32}$  and  $\text{Fe}^{59}$  were employed, have shown that  $\text{P}^{32}$  incorporation rate is the same for normal and malignant tissue, while that for  $\text{Fe}^{59}$  was lower for tumor tissue than for normal tissue (small intestine, spleen, liver, and whole blood). To increase the Fe incorporation into tumor tissue the Fe-ascorbate and Fe-tartrate are recommended. (auth)

### 3368

SPECIES SPECIFICITY ACTION OF TISSUE HEMOLYSIS, FORMING IN THE LIVER OF IRRADIATED ANIMALS.

V. N. Benevolenski. *Med. Radiol.* **4**, No. 11, 47-51 (1959) Nov. (In Russian)

The problem of species specificity of the hemolytic factor of the liver in irradiated animals was investigated. It is shown experimentally that the hemolytic factor does not possess a species specificity action. The species specificity of the hemolytic factor of the liver of irradiated mice is in reality nonspecific and depends upon the lesser resistance of erythrocytes of mice to the action of any tissue hemolysins. (auth)

### 3369

SKIN DISACTIVATION IN CONTAMINATION WITH RADIOACTIVE SUBSTANCES. Ya. Nosek and V. Khmelarzh (Karlovy Med. Inst., Czechoslovakia). *Med. Radiol.* **4**, No. 11, 74-6 (1959). (In Russian)

The authors studied the conditions of disactivation of the intact skin contaminated with the salts of the following radioisotopes:  $\text{Cs}^{134}$ ,  $\text{Sr}^{90}$ ,  $\text{Y}^{90}$ ,  $\text{Pr}^{144}$ ,  $\text{Ce}^{144}$ ,  $\text{Co}^{60}$ ,  $\text{Rh}^{106}$ ,  $\text{Ba}^{140}$ ,  $\text{La}^{140}$ ,  $\text{Zr}^{95}$ ,  $\text{Nb}^{95}$ , and  $\text{I}^{131}$ . Of the 158 decontaminating substances the following mixture was found to be the best: complexon III-10 gm, kaolin-10 gm, starch-5 gm, sodium laurylsulfonate-5 gm, and sodium bicarbonate-70 gm. This mixture washed off the rabbit's skin up to 90% of the radioactivity applied and up to 96% from the suckling pig's skin. (auth)

### 3370

LOW-TEMPERATURE AUTORADIOGRAPHY FOR THE DETECTION OF TRITIUM IN TISSUE, WITH REMOVAL



OF LUMINESCENCE INDUCED BY TRITIUM. P. Pellerin, P. Falot, M. Laine-Boszormenyi, and F. Serrel (Commissariat à l'Énergie Atomique, Paris). *Nature* **184**, 1385-6(1959) Oct. 31.

A procedure is described for obtaining an image of homogeneous diffusion of tritium-labeled water in organisms under conditions close to equilibrium. The procedure consists of low-temperature autoradiography. Characteristics of the luminescence produced by the local absorption of tritium beta radiation by certain tissues were formulated, and the effects of a screen of opaque light on this luminescence are discussed. The luminescence effect was not observed in autoradiograms made with sulfur-35 and calcium-45. It was concluded that the luminescence effect of tissues at very low temperature is only detectable for extremely soft radiations such as that of tritium. (C.H.)

### 3371

DISTRIBUTION OF SODIUM IN COMPACT BONE, AS REVEALED BY AUTORADIOGRAPHY OF NEUTRON-ACTIVATED SECTIONS. J. Vincent (Lovanum Univ., Léopoldville, Belgian Congo). *Nature* **184**, Suppl. 17, 1332-3(1959) Oct. 24.

The distribution of sodium in compact bone of rats was investigated by means of autoradiography after neutron activation of sections. Observations show that sodium parallels the load of calcium as indicated by x rays. The concentration of sodium was observed to be lower in young osteons than in old ones, and lower in the skeleton of young rats than in that of old rats. (C.H.)

### 3372

ATTEMPTS TO MODIFY THE NORMAL METABOLISM OF STRONTIUM-90 IN RATS. V. Volf (Inst. of Industrial Hygiene and Occupational Diseases, Prague). *Nature* **184**, Suppl. 18, 1401(1959) Oct. 31.

An investigation was made of the effects of orally administered barium sulfate or calcium phosphate on the fecal excretion of strontium-90 administered intraperitoneally to rats. The effect was also studied of the administration of zirconium citrate intraperitoneally half-an-hour before the strontium-90 was administered. The possibility of decreasing intestinal absorption of strontium-90 using tertiary calcium phosphate was also studied. Data are presented graphically and results are discussed. (C.H.)

### 3373

PREVENTION OF PERITONEAL FREE (ASCITES) TUMOR CELL GROWTH AND IMPLANTATION BY PRETREATMENT WITH RADIOACTIVE YTTRIUM. Horace Goldie, Spencer C. Disher, Charles S. Smith, and Frank B. Davis (Meharry Medical Coll., Nashville). *Proc. Soc. Exptl. Biol. Med.* **102**, 295-9(1959) Nov.

Doses of 0.25 mc of radioactive yttrium phosphate ( $Y^{90}PO_4$ ) were injected into peritoneal cavity of Albino mice immediately following administration of 2 ml of 0.85% NaCl solution. On 3rd to 4th day  $10^5$  cells of Krebs-2 Ascites Tumor were inoculated by same route into pretreated animals and normal controls. Their accumulated fluid was withdrawn after 3 or 4 days for estimate of its volume, tumor cell counts and smears, and they were sacrificed for autopsies 1 or 2 days later. Amount of ascitic fluid and extent of implant growth were considerably reduced in pretreated animals as compared with controls. Free tumor cells in the fluid appeared enlarged, altered (distorted mitoses) and less viable, after transfer into new mice, than in controls. Decrease of their concentration in the fluid was not as rapid and extensive as in animals treated with an isotope after inoculation in previous experiments. Cell destruction was increased by injection of 0.1 mc into pre-

treated mice. It was concluded that pretreatment with radioactive yttrium increased resistance of the peritoneum to invasion with tumor cells, thus decreasing implantation of these cells and exudation of the fluid. It was presumed that the principle of this method may be eventually applied for prevention of transcoelomic metastases from some abdominal tumors, before or after their removal. (auth)

### 3374

FURTHER STUDIES OF GASEOUS ION ACTION ON TRACHEA. A. P. Krueger, R. F. Smith, G. J. Hildebrand, and C. E. Meyers (Univ. of California, San Francisco). *Proc. Soc. Exptl. Biol. Med.* **102**, 355-7(1959) Nov.

The trachea of the living rabbit was observed during exposure to un-ionized and ionized  $N_2$ ,  $O_2$ , and  $CO_2$  using a separate airway for respiration. Positively charged  $CO_2$  was found to be responsible for reduction of ciliary activity, contracture of smooth muscle, ischemia, and enhanced vulnerability to trauma. (auth)

### 3375

THE EFFECTS OF LIGNIN ON THE DEGRADATION OF WOOD BY GAMMA IRRADIATION. D. Morrison Smith and R. Y. Mixer (Stanford Research Inst., Menlo Park, Calif.). *Radiation Research* **11**, 776-80(1959) Dec.

Gamma radiation from cobalt-60 does not affect the gross analytical composition of redwood. The naturally occurring aromatic compounds in redwood (lignin and other extractives) reduce the number of scissions of cellulose chains caused by this same radiation. (auth)

### 3376

THE EFFECT OF TRITIATED THYMIDINE ON MOUSE SPERMATOGONIA. Horton A. Johnson and Eugene P. Cronkite (Brookhaven National Lab., Upton, N. Y.). *Radiation Research* **11**, 825-31(1959) Dec.

The effect of tritiated thymidine on the development of mouse spermatogonia has been studied quantitatively. In this cellular system the biological effects of doses under  $1 \mu\text{c/gm}$  of body weight are comparable to less than 2 r of  $\gamma$ -irradiation per day. (auth)

## Biochemistry, Nutrition, and Toxicology

### 3377

PHYSIOLOGY AND TOXICOLOGY OF PLUTONIUM-239 AND ITS INDUSTRIAL MEDICAL CONTROL. W. H. Langham (Los Alamos Scientific Lab., N. Mex.). *Health Phys.* **2**, 172-85(1959) Oct.

When taken into the systemic circulation,  $Pu^{239}$  deposits predominantly in the skeleton, where it may produce bone disease (including cancer) many years later. Its absorption rate from the gastrointestinal tract is only about 0.003%. A small amount may be absorbed through the intact skin and through contaminated cuts and puncture wounds. Absorption from the lung may be from 1 to 10% of the inhaled dose, depending on particle size, solubility, chemical form, etc. Inhalation of contaminated air is potentially the most important mode of exposure, and its control is largely responsible for the rigorous closed-systems and other industrial hygiene and engineering practices employed in plutonium processing. Once in the body,  $Pu^{239}$  is excreted extremely slowly (about 200 years being required to eliminate one-half the body burden). An individual who has reached the maximum permissible body burden technically should be removed from further plutonium contact for the rest of his life. The maximum permissible body burden of  $Pu^{239}$  ( $0.04 \mu\text{c}$ ) is established by



comparison with  $Ra^{226}$  and is that amount which has the same improbability of producing harm to any person at any time during his natural life as does  $0.1 \mu\text{c}$  of fixed  $Ra^{226}$ . Control of the industrial hazards of  $Pu^{239}$  processing is based on the premise that exposure of personnel should be as nearly zero as possible. If presently recommended practices are maintained, there is little reason to feel that the health of a person working with  $Pu^{239}$  will be subject to any greater absolute risk than if he were engaged in any other chemical or industrial occupation. (auth)

## Fallout and Radiation Ecology

### 3378 AFSWP-501(Del.)

Armed Forces Special Weapons Project, Washington, D. C. THE RESIDUAL RADIOLOGICAL HAZARD FROM THE AIR DETONATION OF AN ATOMIC WEAPON IN THE RAIN. L. D. Gates, T. A. Gibson, Jr., P. S. Gwynn, and J. F. Camu. May 1953. Decl. with deletions Sept. 15, 1959. 48p. OTS.

The residual radiological hazard which might result from the use of an atomic weapon air burst during a continuous rain situation was investigated. This required a consideration of atomic cloud heights and dimensions in rainy weather, of radioactive decay, of the scrubbing action by rain and other precipitation which brings radioactive debris to the ground, of the altitudes of precipitation levels, of the times required for the radioactive material to reach the earth, and of the reduction in the residual radiation due to shielding by surface features. A mathematical method taking these factors into account was devised to calculate dosage and dose rate. Calculations were made for yields from 1 to 14 KT. The results showed that for yields of 8 KT and greater detonated under the most adverse weather conditions the maximum residual radiation dosage during the first day does not exceed 100 roentgens. For smaller yields, on the other hand, the rainout of radioactive material under very adverse weather conditions might provide a hazard to personnel located downwind and outside the hazard area of initial radiation and other effects. This is due to the fact that, although the total amount of residual radioactive material produced by the detonation is greater for the larger yields, the updrafts carry the bulk of this material up through the weather to an altitude above the level of precipitation. It is concluded that this estimation of the hazard is sufficiently reliable for operational planning and that a full-scale atomic test in rain is not necessary to verify the magnitude and extent of the hazard. (auth)

### 3379 C3-36417(Del.)

Air Research and Development Command, Andrews AFB, Md.

RADIOACTIVE FALL-OUT FROM ATOMIC BOMBS. N. M. Lulejian. Nov. 1953. Decl. with deletions Sept. 29, 1959. 66p. OTS.

The radioactive fall-out from tower shots of TUMBLER/ SNAPPER and UPSHOT/KNOTHOLE Test Operations has been plotted in detail utilizing the radiological monitoring logs of the ground and air monitors. It was concluded there is no excessive radioactive fall-out from an atomic bomb if the fireball does not touch the ground. It is possible to detonate some types of shots regardless of weather conditions without producing excessive radioactive contamination. It is possible to delineate the general fall-out area adequately using a simple Stokes' Law analysis of the winds and assuming that the particle size varies from 150 microns to 75 microns, and the average density of the particles is 2.5 grams per cubic centimeter. The radex

based on the actual wind observations made three hours prior to shot time indicates the general fall-out area adequately. It is suggested that the decision to fire a contaminating tower shot be made after consulting the radex plot based upon the latest available winds prior to shot time. It is estimated that 50,000 to 200,000 tons of sand and soil debris are sucked up into the stem and mushroom of an atomic cloud when a nominal bomb is detonated from a 300 ft tower. In view of this, it is suggested that the radioactive fall-out due to the relatively small mass of the tower would be negligible. If it is intended to use soil stabilization to reduce fall-out, the soil within a radius of approximately one mile from ground zero must be stabilized by cement or other permanent methods. Extrapolation of the fall-out information in this report to the case of 10 megaton bombs exploded on the surface indicates that lethal concentration of radioactivity may extend 30 to 50 miles downwind. (auth)

### 3380 ITR-1512(Del.)

Air Force Special Weapons Center, Kirtland AFB, N. Mex. MONITORING AND DECONTAMINATION TECHNIQUES FOR PLUTONIUM FALLOUT ON LARGE-AREA SURFACES. E. A. Pinson, R. F. Merian, B. B. Boecker, and J. L. Dick. May 1957. Test Group 57, Program 73 [of] OPERATION PLUMBBOB. OTS.

Decontamination methods tested on hard surfaces include vacuuming, high-pressure hosing with water, high-pressure hosing with water followed by scrubbing, high-pressure hosing with water detergent, high-pressure hosing with water detergent followed by scrubbing, sand-blasting, and steam cleaning. Hard-surface areas include concrete, asphalt, plate steel, aluminum, galvanized roofing, tar-paper roofing, unpainted wood, painted wood, glass, brick, stucco, wood shingles, and asbestos shingles. Flats of grass were also exposed. The effectiveness of decontamination methods for large land areas was determined by air sampling during resuspension of the contaminant before and after the decontamination operation and by soil sampling. Decontamination methods tested on land areas included plowing, disking, oiling, soaking with fire foam, sprinkling with water, sprinkling with a water-Alconox solution, flooding with water, and wetting with aqueous ferric chloride solution. Present data available indicate that surface monitor readings decrease with time after the shot. Similarly, air concentration decreased rapidly after cloud passage and varied thereafter according to existing weather conditions; i.e., wind and rain. The most effective means of hard-surface decontamination are listed in order of efficiency as follows: sandblasting, water-detergent scrubbing, water-detergent hosing, water hosing, water scrubbing, steam cleaning, and vacuuming. Effectiveness varied from 98.3 to 66.4%. Operationally, the simplest method for pad decontamination appears to be water-detergent hosing. The most effective means of large land-surface decontamination are listed in order of efficiency as follows: plowing, oiling and scraping, scraping, leaching with 0.3 in. of water and scraping, oiling, leaching with 1 in. of water, leaching with 0.3 in. of a water- $FeCl_3$  solution, disking, and leaching with 0.3 in. of a water-Alconox solution. Efficiencies varied from 98.3 to 3.0%. The contaminated vehicles and test equipment were readily decontaminated below AEC tolerance level. (auth)

### 3381 RM-2115(RAND)(Del.)

RAND Corp., Santa Monica, Calif.

A NEW MODEL FOR FALLOUT CALCULATIONS (U). R. R. Rapp. Feb. 13, 1958. Decl. with deletions Sept. 29, 1959. 45p. OTS.



This paper presents a new model for the machine calculation of fall-out patterns. The model is divided into meteorological, which considers wind velocity and the fall velocity of the particles; geometric, which considers distribution of activity on particles in the cloud as a function of height and particle size; and radiological, which considers the radiation doses of particles on the ground. The use of the model is illustrated, and the changes in the model that will provide an optimum model, which is currently being developed, are discussed. (auth)

### 3382 USNRDL-TR-364

Naval Radiological Defense Lab., San Francisco.  
IDENTIFICATION OF MICRON-SIZED, INSOLUBLE-SOLIDS FALLOUT PARTICLES COLLECTED DURING OPERATION REDWING. W. R. Schell. Sept. 24, 1959. 20p.

Fall-out from REDWING shots Flathead and Navaajo, detonated on barges anchored in shallow water, is described. The insoluble solids formed by the vaporization and subsequent condensation of the barge, coral ballast, fission products, and environmental sea salts were analyzed through electron diffraction, electron microscopy, emission spectrography, photomicrography, and x-ray diffraction. These insoluble solids were found to consist primarily of spherical particles less than  $1\ \mu$  in diameter and to be composed of compounds and elements consistent with the environmental materials. (auth)

### 3383

THE AIR CONTENT OF LONG-LIVED  $\gamma$ -IRRADIATING SUBSTANCES. A. Wensel (Max-Planck-Institut für Biophysik, Frankfurt am Main). *Atompraxis* 5, 419-21 (1959) Oct.-Nov. (In German)

Six filter bands from a continuous air-monitoring system were charred. The activity of individual nuclides in the ash, and thus in the atmosphere close to the ground, was estimated by examination in a gamma spectrometer and comparison with a standard solution. Likewise, the amount of long-lived fission products in the air can be determined from the percentages of the individual nuclides in total gamma activity. Both methods indicate an average  $\text{Cs}^{137}$  activity of about  $3 \times 10^{-15}\ \mu\text{C}/\text{cm}^3$  in the air close to the ground. (auth)

### 3384

THE VERTICAL PROFILE OF RADIOACTIVE EMANATION IN ATMOSPHERE. S. G. Malakhov (Inst. of Applied Geophysics, Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Geofiz.* No. 9, 1344-52 (1959) Sept. (In Russian)

Theoretical calculations were made of the vertical profile of radioactive emanations in the atmosphere, and the quantitative ratio between the concentrations of Ru and Th in the soil and atmosphere are estimated. (R.V.J.)

### 3385

ON THE ORDER OF PRECISION IN MEASURING NON-STATIONARY RADIOACTIVE EMISSIONS. R. M. Kogan and I. M. Nazarov (Inst. of Applied Geophysics, Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Geofiz.* No. 9, 1353-8 (1959) Sept. (In Russian)

The relationship between particle activity and dispersal was established for non-stationary radioactive emissions. Formulas were derived for determining the dispersion in certain type non-stationary emissions. Various methods are suggested for determining the time constant for recording instruments. (R.V.J.)

### 3386

METEOROLOGICAL PROBLEMS IN THE CIRCULATION OF RADIOACTIVE AEROSOLS. H. Flohn and H. Haar-

känder. *Schriftenreihe zivil. Luftschutz* No. 11, 181-99 (1958). (In German)

The prediction of particle transport is dependent on the space-time interval of the measuring points, i.e., the scale. The factors in the prediction of large area radio-aerosol transport processes include the strength and height of the nuclear explosion, relative distribution of the radioactive particles, wind distribution in all layers, and turbulence and diffusion. The variability of the wind field is considered. In the discussion on the propagation and fall-out of radioactive particles, a distinction is made between local, tropospheric, and stratospheric fall-out. (J.S.R.)

### 3387

EFFECT OF SOIL NUTRIENTS ON PLANT UPTAKE OF FALLOUT. SOIL CALCIUM AND POTASSIUM DECREASE STRONTIUM-90/CALCIUM AND CESIUM-137/POTASSIUM RATIOS IN PLANTS. Eric B. Fowler and C. W. Christenson (Los Alamos Scientific Lab., N. Mex.). *Science* 130, 1689-93 (1959) Dec. 18.

Data are summarized from a study of the uptake of strontium-90 by plants growing in the radionuclide and controlled concentrations of calcium. It was concluded that high levels of soil calcium and potassium decrease strontium-90 and cesium-137 uptake by plants. The depth of feeding of the plant was also found to be an important factor in the natural absorption of radionuclides arising from fall-out from the soil. (C.H.)

### 3388

PROBLEM OF THE PROPAGATION OF RADIOACTIVE AEROSOLS IN THE AIR. H. Flohn. *Wasser, Luft u. Betrieb* 2, No. 7, 3p. (1958) July. (In German)

The factors controlling the atmospheric propagation of radioactive aerosols and the problems in the evaluation of the proper significance of each factor are discussed. Turbulence, horizontal propagation, jet streams, vertical movements, and the stratosphere are considered. (J.S.R.)

## Radiation Effects on Living Tissues

### 3389 AD-212626

National Canners Assn. Western Research Lab., Berkeley, Calif.

DETERMINATION OF RELATIVE RESISTANCE OF SELECTED STRAINS OF CLOSTRIDIUM BOTULINUM TO IONIZING RADIATIONS. Progress Report No. 1 [for] Period July 14, 1958 - September 13, 1958. Charles T. Townsend. 8p. Project No. 7-84-01-002. Contract DA-19-129-QM-1184.

Data are tabulated from a survey of the radiosensitivity of spores from six strains of *Clostridium botulinum*. (C.H.)

### 3390 AD-212803

Alabama Polytechnic Inst., Auburn.  
LONG-TERM RAT AND DOG FEEDING TESTS ON IRRADIATED SWEETPOTATOES AND COD FISH. Progress Report. H. D. Alexander and W. D. Salmon. Mar. 15, 1958. 11p. Contract DA-47-007-MD-543.

Data are tabulated on the effects of irradiated cod fish and sweet potatoes on survival, body weight, and breeding performance of rats and dogs. (C.H.)

### 3391 BLG-36

Brussels. Centre d'Etude de l'Energie Nucléaire.  
EFFETS ANTIMICROBIENS DES RADIATIONS IONISANTES. (Antimicrobial Effects of Ionizing Radiations). P. Manil. May 1959. 46p.

Recent investigations on the antimicrobial effects of radiation are summarized and analyzed. The subjects con-



sidered include the apparent or actual "death" or inactivation of microorganisms, the mechanisms involved, sterilizing doses, and inactivation curves. The various factors or treatments modifying, either positively or negatively, the radiosensitivity of microorganisms are also discussed. (tr-auth)

### 3392 NP-8074

Massachusetts Inst. of Tech., Cambridge.

BREEDING STUDIES ON DOGS RECEIVING IRRADIATED DRIED WHOLE EGGS. Annual Progress Report for the Period June 15, 1958 to June 15, 1959. S. Miller and Bernard E. Proctor. June 30, 1959. 18p. Contract DA-49-007-MD-755.

No direct relationship was found between the feeding of irradiated eggs to dogs and any pathological manifestation. (C.H.)

### 3393 NP-8075

Massachusetts Inst. of Tech., Cambridge.

BREEDING STUDIES ON DOGS RECEIVING IRRADIATED DRIED WHOLE EGGS. Progress Report for the Period June 15, 1959 to September 14, 1959. S. Miller and Bernard E. Proctor. Sept. 15, 1959. 17p. Contract DA-49-007-MD-755.

Data are tabulated on weight and reproduction in dogs maintained on a diet containing 20% irradiated dried eggs. Data are included on the effects of biotin supplement on reproductive performance. (C.H.)

### 3394 NP-8076

Syracuse Univ., N. Y. Research Inst.

LONG-TERM FEEDING OF IRRADIATED CHICKEN STEW AND COLESLAW TO RATS. Report No. 5 for March 15, 1958 to Sept. 15, 1959. A. W. Phillips. 23p. Contract DA-49-007-MD-783.

Data are tabulated on the growth responses of the third generation of rats maintained on a diet of irradiated chicken stew and coleslaw. Observations over a two-year period indicated that apparently the irradiated diet had no effect on the longevity of the rats. (C.H.)

### 3395 NP-8078

Alabama Polytechnic Inst., Auburn.

LONG-TERM RAT AND DOG FEEDING TESTS ON IRRADIATED SWEET POTATOES AND COD FISH. Progress Report. H. D. Alexander and W. D. Salmon. Sept. 15, 1959. 57p. Contract DA-47-007-MD-543.

Based on data obtained from four generations of rats during a two-year period it was concluded that a diet containing irradiated cod fish and sweet potatoes is as wholesome as one containing the unirradiated foods. (C.H.)

### 3396 NP-8081

Texas. Agricultural Experiment Station, College Station. A LONG TERM FEEDING STUDY ON CHICKEN AND GREEN BEANS. Final Report [for] Period March 1, 1959 to September 15, 1959. General Progress Report No. XIV [on] A LONG RANGE INVESTIGATION OF THE NUTRITION PROPERTIES OF IRRADIATED FOODS. L. R. Richardson. 33p. Contract DA-49-007-MD-582.

Irradiated green beans and chicken were found to be essentially equal to non-irradiated foods in nutritive value and toxic properties for rats. Data are included on growth, food consumption, fertility, reproduction, and longevity of three generations. A comparison was made of the vitamin B<sub>6</sub> content of irradiated, commercially canned, and frozen beef liver, green beans, cabbage, boned chicken, sweet potatoes, and lima beans. The vitamin K content was compared for irradiated, commercially canned, and frozen green beans, cabbage, cauliflower, spinach, broccoli, and

asparagus. The method used in the vitamin determinations are described. Studies are described to determine the nature of the agent producing hemorrhagic syndrome in male rats receiving irradiated beef. (C.H.)

### 3397 NP-8082

Texas. Univ., Galveston. Medical Branch.

PATHOLOGIC CHANGES IN RATS FED CHICKEN AND GREEN BEANS. Final Report [for] Period: December 1, 1957–November 30, 1959. R. H. Rigdon. 13p. Contract DA-49-007-MD-912.

Data are summarized from a study on the effects of diet containing irradiated chicken and green beans on rats. The most significant pathological change observed was the incidence of pulmonary infection. (C.H.)

### 3398 NP-8084

Pennsylvania. Univ., Philadelphia. School of Medicine.

EFFECT OF FOOD PRESERVED WITH IONIZING RADIATION ON RESTORATION OF ENZYME ACTIVITY AND TOTAL PROTEIN OF RAT LIVER. Progress Report No. 4 for March 1959–September 1959. Otto Rosenthal. 12p.

Canned ground beef which had been sterilized with ionizing radiation and incubated at 37°C for three weeks, was effective in restoring protein content and enzyme activity in rat liver after protein depletion and partial hepatectomy. Data are tabulated and results are discussed. (C.H.)

### 3399 NP-8108

Miami. Univ., Coral Gables, Fla. School of Medicine.

LONG-TERM DOG AND RAT FEEDING EXPERIMENT EMPLOYING IRRADIATED MILK AND BEEF STEW (C-RATION). Progress Report No. 5 [for] Period: March 1, 1957 to September 15, 1959. J. L. Radomski. 20p. Contract DA49-007-MD-785.

No toxic effects were noted in dogs maintained for 105 weeks on a diet containing evaporated milk or maintained for 89 weeks on irradiated beef stew. (C.H.)

### 3400 NP-8109

Miami. Univ., Coral Gables, Fla. School of Medicine.

MOUSE CARCINOGENICITY STUDY. Progress Report [for] Period: March 1, 1957 to September 15, 1959. J. L. Radomski. 10p. Contract DA-49-007-MD-789.

The incidence of tumors in four strains of mice maintained for life on an irradiated diet was about the same as that in control groups. The diet consisted of beef, tuna, corn, sweet potatoes, and fruit compote, plus a vitamin supplement. (C.H.)

### 3401 NP-8110

Wisconsin Alumni Research Foundation, Madison.

LONG-TERM FEEDING OF IRRADIATED POTATOES. Progress Report No. III [for] Period: March 15, 1959 to September 15, 1959. H. Von Elbe, B. E. Kline, and J. J. Birdsall. 18p. Contract DA-49-007-MD-712.

No harmful effects due to a diet containing irradiated potatoes were noted in three generations of rats. Data on food consumption and weight gain are tabulated. (C.H.)

### 3402 NP-8111

Oregon State Coll., Corvallis.

THE GROWTH, BREEDING, LONGEVITY AND HISTOPATHOLOGY OF RATS FED IRRADIATED OR CONTROL FOODS. Progress Report. Summary Report [on] ROOM TEMPERATURE STORED IRRADIATED PEACHES. Edward C. Bubl, Joseph S. Butts, and Jesse F. Bone. Sept. 1959. 25p. Contract DA-49-007-MD-580.

Data are tabulated on the effects of a diet containing 35% dry solids of irradiated peaches on four generations of rats. No differences were observed in growth, breeding, longevity, or hematology. An increase in the incidence of



tumors was noted in animals maintained on the irradiated diets. (C.H.)

**3403** NP-8112

Oregon. Agricultural Experiment Station, Corvallis.  
THE GROWTH, BREEDING, LONGEVITY AND HISTO-  
PATHOLOGY OF RATS FED IRRADIATED OR CONTROL  
FOODS (TISSUE ENZYME STUDIES). Second Semi-Annual  
Progress Report [for Period] March 15, 1959 to Septem-  
ber 15, 1959. Ian J. Tinsley and Edward C. Bubl. 9p.  
Contract DA-49-007-MD-580, Report No. 4.

Data are tabulated from tissue enzyme studies on rats  
fed control and irradiated diets of pork, jam, or carrots.  
(C.H.)

**3404** NP-8113

Industrial Bio-Test Labs., Northbrook, Ill.  
THE CARCINOGENIC PROPERTIES OF IRRADIATED  
FOODS. Progress Report No. 4 [for] Period March 1,  
1959 to August 31, 1959. J. C. Calandra and John H. Kay.  
14p. Contract DA-49-007-MD-895.

Mice were maintained on a diet consisting of irradiated  
codfish, beef stew, chicken stew, green beans, peaches, and  
flour, plus a vitamin and mineral supplement. Data on  
growth and mortality are tabulated. Observations on tumor  
incidence will be reported later. (C.H.)

**3405** NP-8114

Saint Louis Univ. School of Medicine.  
HEMORRHAGIC SYNDROME IN RATS FED IRRADIATED  
BEEF. Progress Report No. 2 [for] Period April 1, 1959  
to September 1, 1959. E. A. Doisy, Jr. and J. T.  
Matschiner. 16p. Contract DA-49-007-MD-996.

Data are tabulated on the effect of an irradiated beef diet  
on rats. A marked tendency to hemorrhage was noted with  
mortality from hemorrhage reaching a peak at 9 weeks.  
Data are included from a study of the effects of vitamin A  
on the incidence of hemorrhage. (C.H.)

**3406** NP-8115

Georgia. Univ., Tifton. Georgia Coastal Plain Experi-  
ment Station.  
TO DETERMINE THE EFFECT OF IRRADIATION ON THE  
WHOLESMENESS OF FOOD. Progress Report No. 6  
[for] Period March 15, 1959 to September 15, 1959. M. W.  
Hale, W. F. Schroeder, and D. Sikes. 27p. Contract DA-  
49-007-MD-780.

Data are tabulated from a study of the effects of a diet  
containing 20% of dry weight of irradiated cabbage fed for  
89 weeks to dogs or a diet containing 35% of dry weight of  
irradiated bacon fed for 104 weeks. No differences due to  
diet were noticed in growth, feed efficiency, hemoglobin,  
packed cell volume, white blood cell counts, and reproduction.  
(C.H.)

**3407** NP-8116

Illinois. Univ., Urbana.  
ON THE NUTRITIVE VALUE OF THE MAJOR NUTRIENTS  
OF IRRADIATED FOODS AND APPRAISAL OF THE TOX-  
ICITY OF IRRADIATED FOODS. Progress Report No. 16  
for Period March 16, 1959-September 1, 1959. V. Chalam  
Metta, M. S. Mameesh, P. B. Rama Rao, and B. Connor  
Johnson. 20p. Contract DA-49-007-MD-544.

Progress is reported in studies on the hemorrhagic syn-  
drome observed in rats maintained on a diet containing ir-  
radiated beef. Studies are reported in progress on the sta-  
bility of vitamin K in the beef diet. (C.H.)

**3408** NYO-2979

Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.  
THE OCCURRENCE OF CHROMOSOMAL ABERRATIONS  
IN PRE-SPERMATOCYTIC CELLS OF IRRADIATED MALE

MICE. Progress Report [for] period September 1, 1958-  
October 31, 1959. Allen B. Griffen. Dec. 10, 1959. 11p.  
Contract AT(30-1)-2113. OTS.

Progress is reported in a study of the nature and extent  
of radiation damage to the chromosome system of pre-  
spermatocytic cells in male mice subjected to x irradiation  
at various doses. Data are included on offspring produced  
by each male, and cytological characteristics of chromo-  
somal aberrations capable of producing semi-sterility.  
(C.H.)

**3409** NP-tr-313

ACTION OF VERY WEAK DOSES (5 r) OF X-RAYS GIVEN  
AT BIRTH ON THE LEUKEMOGENESIS OF AKR MICE.  
Georges Rudali and Jean Reverdy. Translated by P. Hajdu  
(National Institutes of Health) from Compt. rend. 248,  
1248-9(1959). 5p.

This paper was previously abstracted from the original  
language and appears in NSA, Vol. 13, as abstract No. 9581.

**3410**

THE REVERSIBLE ALTERATION OF ADENOSINE-  
TRIPHOSPHATE DUE TO RADIATION EFFECTS.  
K. Garay and F. Guba (Agrochemisches Forschungsinstitut,  
Budapest and Universität, Budapest). Acta Physiol. Acad.  
Sci. Hung. 5, 393-9(1954). (In German)

Two kinds of ATP were produced by irradiating under  
selected conditions: a very fast dividing form (S-ATP) and  
a slow one (R-ATP). These two forms are controlled by  
radiation effects on water whereby free radicals are pro-  
duced. By the incorporation of certain radicals the two  
configurations of ATP result. These two configurations can  
reversibly interchange by a free-radical mechanism. This  
is confirmed by UV absorption spectrograms. The struc-  
ture of the ATP modifications and the free radical mecha-  
nisms will be studied further. Destruction of ATP by the  
absence of a  $PO_4^-$ ,  $P_2O_7^-$  or  $NH_3^-$  cleavage is impossible.  
(tr-auth)

**3411**

THE EFFECT OF BETA IRRADIATION ON THE MITOTIC  
CYCLE OF HUMAN CANCER CELLS GROWN IN TISSUE  
CULTURE. John L. Tullis and Maria D. Parsons (Cancer  
Research Inst. of the New England Deaconess Hospital,  
Boston). Acta Unio Intern. contra Cancrum 15, 704-10  
(1959).

Observations are reported on the response of cells of  
human cancer origin grown in tissue culture and subjected  
to single exposures of beta radiation from an yttrium-91  
source. (C.H.)

**3412**

RADIATION-INDUCED MUTATIONS FOR STEM RUST RE-  
SISTANCE IN OATS. C. F. Konzak (Brookhaven National  
Lab., Upton, N. Y.). Agron J. 51, 518-20(1959).

Stem rust resistant variants from earlier experiments  
on the induction of resistance in oats by radiation were  
found to result from natural field hybridization. Recent  
controlled experiments did, however, yield new variants  
at a low frequency in one instance, and no variants in  
another. Both experiments included over 3,000 lines from  
irradiated seeds. One previously unknown type of rust re-  
sistance reaction was obtained in a mutant plant. This mu-  
tant shows a temperature sensitive response for resist-  
ance to race 7A of Puccinia graminis avenae. It was sug-  
gested that some, as yet unknown, modifying factors may  
limit the development of induced changes into mutations.  
(auth)

**3413**

THE GONADAL RADIATION DOSE RECEIVED BY THE  
PEOPLE OF A SMALL AMERICAN CITY DUE TO THE



DIAGNOSTIC USE OF ROENTGEN RAYS. W. D. Norwood, J. W. Healy, E. E. Donaldson, W. C. Roesch, and C. W. Kirklin (General Electric Co., Richland, Wash.). *Am. J. Roentgenol.*, Radium Therapy Nuclear Med. **82**, 1081-97 (1959) Dec.

An evaluation was made of gonad exposures from all diagnostic roentgen procedures employed in a small city. Data are tabulated. (C.H.)

### 3414

THE ACUTE RADIATION SYNDROME. Otto Hug (Phil.-Theol. Hochschule, Regensburg, Ger.). *Arztliche Mitteilungen* **41**, No. 21, 1-16 (1959) July. (In German)

A description of the acute radiation syndrome as observed in the case of the Japanese fishermen exposed in the fall-out from a hydrogen bomb test is given. (T.R.H.)

### 3415

DIFFERENT SENSITIVITIES TO X RADIATION WITH RESPECT TO THE STAGE OF DEVELOPMENT OF THE EMBRYOS OF *LOCUSTA MIGRATORIA MIGRATORIOIDES* (R. AND F.). Giuseppe Colombo (Universita, Padua). *Atti acad. nazl. Lincei Rend., Classe sci. fis., mat. e nat.* **26**, 583-91 (1959) Apr. (In Italian)

The variation in the radiation sensitivity of *Locusta* embryos was studied with various x radiation exposures at embryonic ages from 1 to 6 days. The ED 50 was determined as a measurement of the sensitivity. These values are tabulated, and show that the resistance to irradiation increases rapidly with the age, varying from an ED 50 of 136 r on the first day to 6900 r on the sixth day. The high resistance of insects to radiation was shown to develop during the embryonic stage after organogenesis. (J.S.R.)

### 3416

BIOPHYSICAL BASIS FOR THE APPLICATION OF X RADIATION AND RADIOACTIVE SUBSTANCES. Otto Hug (Max-Planck-Institut für Biophysik, Frankfurt am Main). *Bundesarbeitsblatt* No. 18, 826-31 (1955). (In German)

In the consideration of basic principles of radiation biology which are valid for all types of radiation, the conception of radiation dose is clarified. The effects of single exposures and the duration of the exposure are discussed. The tolerance doses in professional radiation burden are then considered. Relative biological effectiveness of various types of radiation are discussed and tabulated. The radiation biological effects of radioisotopes are considered in some detail, and a tabulation is given of the maximum permissible dose and concentration in air and water. (J.S.R.)

### 3417

THE USE OF LARGE AMOUNTS OF RADIOACTIVE SULFUR IN PATIENTS WITH ADVANCED CHONDROSARCOMAS. I. CLINICAL AND HEMATOLOGIC OBSERVATIONS. Raymond G. Gottschalk, Louis K. Alpert, and Roy E. Albert (George Washington Univ., Washington, D. C. and Veterans Administration Center, Martinsburg, W. Va.). *Cancer Research* **19**, 1070-7 (1959) Nov.

Large amounts of radioactive sulfur ( $\text{Na}_2\text{S}^{35}\text{O}_4$ ) were administered to three patients with advanced chondrosarcomas because of the preferential fixation of the isotope in this tumor. Total amounts of 559 to 926 mc were given in divided intravenous injections. They produced leukopenia with relative neutropenia and thrombocytopenia. The radio-toxic hematologic effects appeared reversible, but they are the limiting factor in the use of large amounts of radiosulfur and require caution in therapeutic trials. No radiation sickness occurred as a result of the injections. In two patients, the rate of progress of the chondrosarcomas

appeared reduced for several months after the  $\text{S}^{35}$  injections, but no marked tumor regression was observed. (auth)

### 3418

STUDIES ON X RAYS AND BREMSSTRAHLEN. L. E. Brownell and E. W. Coleman (Univ. of Michigan, Ann Arbor and Picker X-Ray Corp., Cleveland). *Chem. Eng. Progr.* **55**, Symposium Ser. No. 22, 45-7 (1959).

Some of the factors considered in developing bremsstrahlung sources for medical radiography are discussed. The possibility of using pure beta-emitting radioisotopes with external x-ray targets is discussed. (C.J.G.)

### 3419

RESULTS OF LOCALIZED RADIATION OF THE FETAL LIVER OF THE MOUSE. I. MORTALITY AND STATURE MODIFICATIONS. J. F. Duplan and H. Izadian. *Compt. rend. soc. biol.* **153**, 1111-12 (1959) Nov. 24. (In French)

The localized irradiation of the abdominal region of mouse fetuses causes a mortality of about 30% when the irradiation occurs before the 16th day of intra-uterine life and when the x-radiation dose is between 800 and 1000 r. The mortality appears to occur rapidly in the 72 hours following irradiation. The mortality measured by the reduction in the number of newly born per litter would probably be higher, but the measurement here is based only on the fatalities occurring *in utero*. The stature reduction of the irradiated fetus was only produced 4 times in 86 animals. It occurred on fetuses irradiated with 600 or 800 r on the 13th or 14th day of gestation and sacrificed 72 hours later. (tr-auth)

### 3420

STERILIZING EFFECTS OF X RAYS ON THE WHEAT WEEVIL. Michel Mortreuil. *Compt. rend. soc. biol.* **153**, 1165-6 (1959) Nov. 24. (In French)

The effect of increasing doses of x radiation on the reproduction of *Calandra granaria* was studied. The sterilizing effect does not appear until a dose of 2000 r is given. The minimum dose for complete extermination is about 16000 r. (tr-auth)

### 3421

EFFECT OF X RADIATION ON THE ASCORBIC ACID CONTENT OF SPLEEN TISSUE. André Chevallier and Simone Manuel (Institut de Physique Biologique, Strasbourg). *Compt. rend. soc. biol.* **153**, 1249-53 (1959) Nov. 24. (In French)

The effect of x radiation on the ascorbic acid content of the spleen was studied as a function of the dose rate. Wistar rats with a weight of about 250 g were exposed to whole-body irradiation of single doses of 200 and 400 r and to daily fractional doses of 20 or 50 r. The rats exposed to single 200 r exposures exhibited a very rapid decrease in the ascorbic acid content of the spleen for about 48 hr. The reduction was approximately 60%. An increase in the ascorbic acid then occurred and reached its maximum in 96 hr. A second decrease which is smaller than the first and attains 40% in 150 hr, is then observed. With a single dose of 400 r the decrease in ascorbic acid is extremely rapid even two hours after irradiation. The decrease continues without interruption except for a slight arrest at 50 hr. The animals exposed to fractional doses were sacrificed 24 hr after the last irradiation. For fractional doses of 50 r a definite decrease in ascorbic acid is noticed after only one exposure. The decrease continues progressively as a function of the total dose and is 50% for 400 r. For fractional doses of 20 r, no decrease in ascorbic acid is found until the total exposure is 250 r, and for



500 to 600 r the decrease is of the order of 10 to 15%. (J.S.R.)

### 3422

#### THE MECHANISM OF THE ACTION OF X RADIATION ON THE ASCORBIC ACID CONTENT OF SPLEEN TISSUE.

André Chevallier and Simone Manuel (Institut de Physique Biologique, Strasbourg). *Compt. rend. soc. biol.* **153**, 1254-7(1959) Nov. 24. (In French)

A study was made in an attempt to determine the mechanism of x-radiation effects on the ascorbic acid content of spleen of rats. In the irradiation of spleen tissue *in vitro* no variation in the ascorbic acid concentration was observed between the sample and the control. The irradiation of the spleen alone with the rest of the animal protected causes no drop in ascorbic acid, but the irradiation of the whole body with the spleen protected causes a sharp decrease in ascorbic acid concentration. The protective effects of mopazine, administered in three doses of 1 mg each 10 min before and 5 and 10 hr after irradiation, were studied. The results showed a decrease of the ascorbic acid of 25 to 70% according to the radiation exposure. The irradiation of newly born rats resulted in only a slight difference in the ascorbic acid concentration and indicated that irradiation has no effect on the spleen of young rats. The administration of ACTH to the newly-born rats resulted in some decrease of ascorbic acid in the irradiated animals. It is concluded that the mechanism is quite complex and can not be defined with the present data. (J.S.R.)

### 3423

CYTOCHEMICAL CHANGES IN NUCLEOPROTEIDS OF NERVE CELLS IN MAMMALS, OBSERVED AT EARLY STAGES OF RADIATION INJURIES. A. L. Shabadash, T. I. Zellkina, and N. D. Agracheva (Inst. of Biological Physics, Academy of Sciences, USSR). *Doklady Akad. Nauk S.S.S.R.* **128**, 1290-3(1959) Oct. 21 (In Russian)

The physicochemical properties of mitochondria ribonucleoproteids (RnP), considering the morphology of the cell organoids, were studied in white mice weighing 220 to 250g and exposed to  $\gamma$  radiation doses of 1000r at 150 to 192r/min. (R.V.J.)

### 3424

INJURY BY IONIZING RADIATION. Otto Hug (Max-Planck-Institut für Biophysik, Frankfurt am Main). *Landarzt* **32**, No. 4, 78-83(1956) Feb. 10. (In German)

Some information on injury to man by radiation from therapy, isotopes, and atomic explosions is collected and discussed. (T.R.H.)

### 3425

MORPHOLOGICAL CHANGES OF VARIOUS PERIPHERAL NERVOUS SYSTEM COMPONENTS IN THE ACTION OF IONIZING RADIATION ON THE ORGANISM. V. V. Anisimova-Alexandrova (Smolensk Med. Inst.). *Med. Radiol.* **4**, No. 11, 3-9(1959) Nov. (In Russian)

The author investigated the nerve elements in the dura mater and the eye muscles of animals subjected to the radiocobalt ( $\text{Co}^{60}$ ) irradiation of daily doses of 1000 to 1500 r in case of rabbits, 400 r in guinea pigs, and 600 to 900 r in rats. The highest radiosensitivity in the dura mater was manifested by the afferent nerve conductors, the cylinders of which become degenerated and disintegrate in 2 to 3 days after the irradiation. Delicate sympathetic fibers were found to be more resistant. The sensory nerves and their endings remain intact in the eye muscles of the same animals. At the same time the motor nerve fibers and their terminal ramifications in the motor end plates appear to be the least resistant and exhibit various degrees of injury up to complete degeneration and lysis of

the end-plate neurofibrillar apparatus from which only the protoplasmic soles are left. As experimentally demonstrated the elements of the peripheral nervous system exhibit a considerable, morphologically manifested, reaction to the action of ionizing radiation. The radiosensitivity exhibited by various peripheral nervous system components is far from being uniform. This depends not only on their nature and functional significance, but also on some still obscure factors. (auth)

### 3426

SOME MORPHOLOGICAL AND HISTOPATHOLOGICAL CHANGES OCCURRING IN THE CENTRAL NERVOUS SYSTEM OF WHITE RATS IRRADIATED DURING THE ANTENATAL PERIOD. M. M. Alexandrovskaya (Inst. of Higher Nervous Activity, Academy of Sciences, USSR). *Med. Radiol.* **4**, No. 11, 10-14(1959) Nov. (In Russian)

Disturbances of embryogenesis in different structures of the brain (atrophy of the cortex of large hemispheres, corpora callosa, striatum, hippocampus) were observed in the progeny of white rats at remote dates following total irradiation of the gravid animals in the dose of 200 r. Besides edema of the brain and in some cases, even hydrocephalus was noted in the embryos. Defective development of the laminar and the areal structures of the strata, as well as underdevelopment of the V and VI strata of the cortex and large hemispheres in cases complicated by hydrocephalus is, evidently, connected with the fact that the embryos were irradiated at the period of embryogenesis when the cells of the lower cortical layers were the most sensitive to irradiation. The neuroblasts of the superior layers, which mature later than the inferior ones, are disturbed to a lesser degree. The mechanism of morphological changes in the animals irradiated during the antenatal period of development is associated not only with the direct injurious effect of ionizing radiation on the nerve and glia cells at early stages of ontogenesis, but also depends upon the toxic-anoxic and metabolic changes developing in the brain. (auth)

### 3427

THE CHANGE OF THE RADIORESISTANCE IN THE IRRADIATED ORGANISM. S. N. Alexandrov and K. F. Galkovskaya (Central Scientific Research Inst. of Medical Radiology, Ministry of Health, USSR). *Med. Radiol.* **4**, No. 11, 15-19(1959) Nov. (In Russian)

The change of the radioresistance in irradiated animals is undulating in character and consists of the alternating periods of rise and decrease of the animal's resistance to repeated irradiation at 400 r. The character of the radioresistance changes depends on the dose of the primary irradiation, particularly, on whether the given dose was below the threshold causing radiation sickness or above it. Variations of the radioresistance in the irradiated animals coincides with the same change of their resistance to the action of a number of other alternating agents. The author revealed a considerable difference in the radioresistance occurring directly after the irradiation with the dose provoking radiation sickness, as compared to that following irradiation dose below this threshold. In the first case the mortality rate of the animals decreases during acute radiation sickness, as well as during the period of late infectious complications connected with repeated irradiation. In the second case late infectious complications are not included in the period of animal resistance. The occurrence of malignant tumors in the animals repeatedly irradiated during the period of radioresistance does not differ from that in the control group. (auth)



**3428**

THE ROLE OF THE HUMORAL FACTORS IN THE BODY REACTIONS TO THE ACTION OF IONIZING RADIATION. A. T. Sverdlov. *Med. Radiol.* 4, No. 11, 19-24(1959) Nov. (In Russian)

The role of the humoral factors in the body reaction to local irradiation has been studied experimentally. Irradiation of a rabbit's ear is associated with characteristic blood changes only when humoral connections of the irradiated field with the organism are preserved. Ear irradiation does not provoke any significant changes in the morphological blood composition. Intravenous injection of the perfusate obtained from irradiated isolated ear to the intact animals provokes blood changes characteristic of radiation sickness. The tonic effect of the perfusate is removed by boiling. (auth)

**3429**

CHANGES IN THE ACTIVITY OF THE ADRENAL MEDULLA IN THE ACTION OF IONIZING RADIATION UPON THE BODY. A. V. Tonkikh and Ts. L. Yankovskaya (Parlov Inst. of Physiology, Academy of Sciences, USSR). *Med. Radiol.* 4, No. 11, 25-9(1959) Nov. (In Russian)

The author employed the presence of the second wave of the blood pressure rise, appearing late after delivering a pain stimulus, as an activity index of the adrenals medulla. This wave is caused by adrenaline secreted by the adrenals. Following a single ionizing irradiation in the dose of 800 r a pain stimulus of the extremity causes a two-wave rise of the blood pressure only during the first 6 days after the irradiation. In 7 to 8 days, and later, only the first wave appears. The absence of the second wave of the blood pressure rise points to a decreased function of the medulla of adrenal glands, i.e., it does not secrete adrenaline. This may be one of the causes of hypertension in radiation sickness. (auth)

**3430**

THE DIFFERENCE IN THE BIOLOGICAL EFFECT OF X RAYS AND RADIOCOBALT RADIATION ON MAMMALS. G. K. Ochinskaya (Central Scientific Research Inst. of Roentgen-Radiology, Ministry of Health, USSR). *Med. Radiol.* 4, No. 11, 29-33(1959) Nov. (In Russian)

Experiments were performed on mice. The author compared the biological effect of x-ray irradiation of moderate hardness and of the radiocobalt  $\gamma$  irradiation under conditions excluding the influence of their different penetrating capacity. Special paraffin phantoms were employed. The doses equaled 700, 1000, and 1500 r with the same dose rate and the same distribution of the dose. The proportion of surviving animals, their average life span, and the degree of corneal radiation injury served as criteria in evaluating the action of the irradiations. The distinction between the action of x rays and those of radiocobalt is possibly connected with the varying specific ionization caused by these radiations and the difference in fluctuations of the energy absorbed by various tissues. (auth)

**3431**

DEVELOPMENTAL ABNORMALITIES IN THE PROGENY OF GUINEA PIGS SUBJECTED TO GAMMA-IRRADIATION. A. I. Osipovskii and G. S. Kunicheva (Sechenov Medical Inst.,). *Med. Radiol.* 4, No. 11, 37-42(1959) Nov. (In Russian)

The authors studied the offspring of three generations of guinea pigs subjected to gamma-irradiation in doses of 225 and 450 r. Among the offspring of the first, second, and third generation the following developmental abnormalities were revealed: disturbance in the development

of the skeleton, teeth, dwarfness, neoplasms, affection of the central nervous system, stillbirths, as well as a reduced viability. (auth)

**3432**

THE EFFECT OF X-RAY IRRADIATION OF GRAVID ANIMALS ON THE MORPHOLOGICAL COMPOSITION OF THE BLOOD AND THEIR OFFSPRING. N. M. Andriyashcheva (Inst. of Obstetrics and Gynecology, Academy of Medical Sciences, USSR). *Med. Radiol.* 4, No. 11, 42-7 (1959) Nov. (In Russian)

In irradiation of gravid rats up to the 12th day of pregnancy the hematological signs of radiation sickness are absent in their progeny. Upon irradiation on the 12th to 14th day of pregnancy marked hematological symptoms of radiation sickness in some progeny of the irradiated rats. The most pronounced hematological symptoms of radiation sickness are found in the newborns when the gravid rats are subjected to irradiation on the 15th to 16th day of gestation. The above coincide with the term of myeloid tissue formation in the bone system. The sensitivity of the hematopoietic system of intra-uterine fetuses to irradiation is somewhat decreased on the 17th day and later. (auth)

**3433**

THE INFLUENCE OF X-RAY IRRADIATION ON THE COURSE OF ACUTE SALMONELLOSIS. B. A. Chuklovin (Naval Medical Academy). *Med. Radiol.* 4, 57-9(1959) Nov. (In Russian)

On a series of experiments staged on white mice the author studied the influence of ionizing radiation on the course of acute salmonellosis. Data of bacteriological investigation and the results of clinical studies testify that irradiation of the organism at any period after infection aggravates the course of the latter. It is manifested not only by the deterioration of external symptoms of the disease but also by the increase of the degree and duration of the generalization of the affection and by the prolongation of the time of clearance of pathogenic microbes from the organism. The course of salmonellosis in mice is most unfavorable when the animals are subjected to the irradiation in the first 10 to 15 days following infection, i.e., in the incubation stage and at the peak of the disease. (auth)

**3434**

THE ADSORPTIVE PROPERTIES OF TISSUES OF THE IRRADIATED ORGANISM AND THEIR CHANGES IN PENICILLIN THERAPY. O. G. Alekseeva. *Med. Radiol.* 4, No. 11, 66-71(1959) Nov. (In Russian)

The experiments were staged on rabbits subjected to x ray irradiation (800 r). The adsorptive properties were studied with the cells of blood, liver, kidneys, spleen, small intestine, mesenteric ganglia, and muscles with respect to live culture of *Staphylococcus albus*. In the irradiated rabbits the changes of adsorption were insignificant and they did not lead to the impairment of this protective function of the organism. The changes were most pronounced in the liver and were characterized by an increase of the adsorptive capacity. The introduction of penicillin for curative purposes to nonirradiated animals could provoke an inhibition of adsorptive properties of tissues, whereas in the irradiated rabbits this inhibitory influence of penicillin was less distinct. Moreover in the first 3 days following irradiation it even activated the process. In the author's opinion, the intensification of adsorptive properties in the liver and kidneys upon the action of various irritants on the organism demonstrates the compensatory ability of the latter. (auth)



**3435**

CHANGES OF THE NERVOUS APPARATUS OF THE SPLEEN IN EXPERIMENTAL IRRADIATION OF ANIMALS. A. A. Schastlivtseva (Kazan Medical Inst.). Med. Radiol. 4, No. 11, 82-4(1959) Nov. (In Russian)

Radioinduced alterations of spleen nerve fibers were studied in cats exposed to whole-body irradiations of 700 to 1500 r. (R.V.J.)

**3436**

POSSIBLE MECHANISM OF CYSTEINE PROTECTION AGAINST RADIATION CATARACT. A. Pirie and L. J. Lajtha (Univ. of Oxford). Nature 184, 1125-7(1959) Oct. 10.

Cysteine was found to arrest cell division in the lens epithelium of irradiated rabbits, and if given before irradiation the number of fragmented nuclei that develop afterward is reduced. Previous findings of the protection afforded by cysteine against radiation cataract were confirmed. Possible reaction mechanisms are confirmed. (C.H.)

**3437**

X-RAY DAMAGE AND RECOVERY IN MAMMALIAN CELLS IN CULTURE. M. M. Elkind and Harriet Sutton (National Institutes of Health, Bethesda, Md.). Nature 184, 1293-5(1959) Oct. 24.

Cells of hamster ovarian and lung tissues propagated in culture medium did not display heritable damage from x irradiation. They repaired their accumulated damage before their first division after irradiation. Contexts in which the findings are of interest are discussed. (C.H.)

**3438**

CROSS-LINKING OF CELLULOSE ACETATE BY IONIZING RADIATION. S. H. Pinner, T. T. Greenwood, and D. G. Lloyd (Tube Investment Research Labs., Hinxton Hall, Cambridge, Eng.). Nature 184, 1303-4(1959) Oct. 24.

Results from a study of cross-linking of cellulose acetate by ionizing radiation led to the conclusion that cross-linked cellulose acetate arises as a consequence of irradiation in the presence of a network-forming monomer, which has a short propagation chain-length and serves as an efficient trap for polymeric radicals whether produced directly by radiation or indirectly by hydrogen abstraction. (C.H.)

**3439**

A 'PROGRESSIVE' MUTATION INDUCED IN POA PRATENSIS L. BY IONIZING RADIATION. A. A. Hanson and F. V. Juska (U. S. Dept. of Agriculture, Beltsville, Md.). Nature 184, Suppl. 13, 1000-1(1959) Sept. 26.

Plants resistant to stem rust resulted from the seed from Merion Kentucky bluegrass plants (Poa pratensis) exposed to thermal neutron radiation. Results indicate that when hybridizing is difficult, radiation may be an effective tool for introducing variation within the progeny of selected individuals. (C.H.)

**3440**

A CONTRIBUTION TO THE PROBLEM OF THE NERVOUS SYSTEM FOR INCREASED O<sub>2</sub>-CONSUMPTION DURING IRRADIATION. Antonín Vacek (Czechoslovak Academy of Sciences, Brno). Naturwissenschaften 46, 606(1959) Nov.

The O<sub>2</sub>-consumption in chordotomized rats was measured for 10 which were irradiated at 50 r/min for 1 to 10 min and 10 controls operated but not chordotomized and also irradiated. Oxygen consumption immediately rose for the controls, but dropped slightly for the chordotomized rats proving that chordotomy lowers O<sub>2</sub>-consumption in irradiated rats. (T.R.H.)

**3441**

RELATIVE INDIVIDUAL RADIOSENSITIVITY OF EARLY-FORMED PLASTIDS IN LEGUMES. W. Herbst (Universität, Freiburg i. B.). Naturwissenschaften 46, 606-07(1959) Nov.

Seeds of Pisum sativum were irradiated in dry condition to doses between 400 and 12,000 r (20 mA, 150 kv). From 1000 r and up the plastid apparatus of the young plants was disturbed and the leaves were not a normal green. A mosaic mottling ranging from green to white resulted. Other observations and conclusions were made. (T.R.H.)

**3442**

A THEORETICAL APPROACH TO THE RADIATION DOSE-RATE DISTRIBUTION FROM COMBINED X- OR  $\gamma$ -RAY BEAMS WITH SPECIAL REFERENCE TO WEDGE-FILTERED BEAMS. R. Sear (London Hospital Research Labs.). Phys. in Med. Biol. 4, 10-25(1959) July.

An analytical treatment is developed which allows prediction of the clinically important features of the resultant field when two similar wedge fields are superposed. An extensive analysis of the results obtained using a number of different wedge sizes with cobalt  $\gamma$  rays, shows that the predicted values agree with those obtained by the conventional graphical method of summation over a wide range of inclinations and linear separations of the two fields. It is shown that using information obtained from the isodose charts of single wedge fields, the clinical data required for planning treatments using superposed fields may be simply computed. This data, together with a knowledge of the effect of varying any of the physical parameters, eliminates the need to issue to the radiotherapist full isodose charts covering all possible clinical arrangements. The various mathematical relationships obtained are used to deduce the practical limitations that are imposed on the physical parameters of the system when the principles governing radiotherapeutic practice are applied. It is also shown that the magnitude of the hot spot found near the port of entry of each field is simply related to an attenuation coefficient and to the wedge angle. The function of an additional plain field is also discussed. The conditions under which the method would be applicable to the superposition of plain fields are described. (auth)

**3443**

INFLUENCE OF DOSE RATE ON RADIATION EFFECT ON FERTILITY OF FEMALE MICE. Liane Brauch Russell, Kathren F. Stelzner, and W. L. Russell (Oak Ridge National Lab., Tenn.). Proc. Soc. Exptl. Biol. Med. 102, 471-9 (1959) Nov.

In an attempt to contribute to an understanding of unusual radiation sensitivity exhibited by the mammalian oocyte, a non-dividing cell, fertility experiments were carried out to determine the effect of dose rate (fractionation, different intensities of continuous radiation). Fractionation markedly reduced damage to fertility, and division of dose into 10-r fractions was more effective in this respect than division into 25-r fractions. Continuously exposed females were even less affected in breeding performance than females which had received fractionated irradiation, and the lower the dose rate the smaller was the deleterious effect on fertility. In all groups, production, in terms of number of females casting litters, remained at maximum level until beginning of a sudden steep decline that ended in sterility. It is for this reason that some experiments of other investigators, who have measured performance only in terms of the first postirradiation litter, have failed to show similar dose-rate effects. The results indicate that some repair of radiation damage to oocytes can occur, and that repair is greater at lower dose rates. (auth)



## 3444

EFFECT OF MICROBIAL ANTIGENS ON IRRADIATION MORTALITY IN MICE. E. J. Ainsworth and H. B. Chase (Brown Univ., Providence). Proc. Soc. Exptl. Biol. Med. **102**, 483-5(1959) Nov.

Irradiation mortality is reduced by approximately 50% in mice injected with zymosan (1000  $\gamma$ ) or with thermostable antigens from *Proteus morgani*, *Klebsiella pneumoniae*, or *Escherichia coli*. Soluble antigens from Gram-positive organisms, however, are ineffective. The greatest reduction of mortality is obtained by means of a Typhoid-Paratyphoid vaccine. (auth)

## 3445

MOVEMENT OF RADIOSTRONTIUM THROUGH INTESTINAL TRACT OF FED OR FASTED RATS. C. F. Cramer (Univ. of British Columbia, Vancouver). Proc. Soc. Exptl. Biol. Med. **102**, 511-12(1959) Nov.

A procedure is described for measuring the progress of strontium-89 through the intestinal tract and the rate of absorption from the intestine. Data are included from applications in fasted and fed rats. (C.H.)

## 3446

PROGRESS AND RATE OF ABSORPTION OF RADIOSTRONTIUM THROUGH INTESTINAL TRACTS OF RATS. C. F. Cramer and D. H. Copp (Univ. of British Columbia, Vancouver). Proc. Soc. Exptl. Biol. Med. **102**, 514-17(1959) Nov.

Rate of absorption of  $\text{Sr}^{89}$  from ligated loops of rat intestine, and rate of passage of  $\text{Sr}^{89}$  through the intact intestinal tract were measured. Assuming only that absorption rate in ligated loops is reasonably the same as rate of absorption from that segment in the intact rat, the actual effective absorption was estimated. The highest initial rate of absorption occurred in the duodenum with jejunum, ileum, colon, and stomach following in decreasing order. Since the radiostrontium passed rapidly through the duodenum and jejunum, the largest actual effective absorption occurred in the ileum (65%), with smaller contributions by the jejunum (17%), colon (8%), duodenum (7%), and stomach (2%). Two factors were found to limit  $\text{Sr}^{89}$  absorption. Movement of the isotope into gut segments caused slower absorption rate, and decreased absorption of  $\text{Sr}^{89}$  was observed in each gut loop with time. (auth)

## 1447

THE RADIATION SENSITIVITY AND MOLECULAR WEIGHT OF DRY  $\beta$ -GALACTOSIDASE. Ernest Pollard and Nancy Barrett (Yale Univ., New Haven). Radiation Research **11**, 781-92(1959) Dec.

Irradiation of dry preparations of *E. coli* adapted to lactose, with  $\text{Co}^{60}$   $\gamma$ -rays, deuterons, and  $\alpha$ -particles, leads to a measured sensitive volume for  $\beta$ -galactosidase of  $4.26 \times 10^{-10}$  cc, an area of  $7.2 \times 10^{-13}$  cm<sup>2</sup>, and an effective thickness of  $5.3 \times 10^{-7}$  cm. These figures support the idea of a spherical molecule of radius 47 Å and molecular weight 330,000. Sedimentation measurements indicated a spread in constants averaging 19 Svedberg units. Irradiation by cobalt  $\gamma$ -radiation in wet C minimal medium gave a slightly higher sensitive volume of equivalent molecular weight 500,000. The insensitivity to radicals produced in water may be due to the enzyme's being protected in a membrane or by its own folding. (auth)

## 3448

INDUCED REVERSION OF  $\text{T4r}_{II}$  MUTANTS BY ULTRAVIOLET IRRADIATION OF EXTRACELLULAR PHAGE. David R. Krieg (Oak Ridge National Lab., Tenn.). Virology **9**, 215-27(1959) Oct.

Extracellular  $\text{T4r}_{II}$  phage were exposed to ultraviolet

light (UV) prior to multiple infection of unirradiated bacteria. The frequency of  $\text{r}_{II}^{+}$  revertants was many times greater among the progeny of irradiated phage than among the progeny of unirradiated controls or untreated parental phage. The conclusion is that these results reflect UV-induced reversions. Reconstruction experiments show that there is no preferential survival or growth of  $\text{r}_{II}^{+}$  phage under these conditions. Observations described in this paper are compatible with the idea that UV irradiation of genes increases the probability of their mutation, even if they are irradiated apart from other cellular constituents. Earlier work with irradiated host cells gave little or no support for this hypothesis. (auth)

## 3449

PECULIARITIES OF TREATMENT IN DAMAGE TO THE LOWER JAW IN CONJUNCTION WITH RADIATION AFFLICTION. A. I. Rybakov. Voenno-Med. Zhur. No. 2, 44-8(1958).

Methods of treatment to the lower jaw in cases involving both gun-shot wound and radiation sickness are discussed. Experiments carried out on 50 dogs and 25 rabbits are described. Results are presented in terms of the experiments conducted on dogs. 20 dogs were irradiated with 400 roentgens, while 20 dogs received 500 roentgens and 10 dogs were not irradiated. All 50 dogs received a gun-shot wound from a small caliber pistol in the lower jaw. Surgical treatment of the wounds was given at 6, 24, and 48 hours after inflicting the wounds with radiation. Before surgery all received, intramuscularly, 300,000 units of penicillin solution, 500,000 units of streptomycin, twice each, and a single injection of a 6% solution of vitamin B<sub>1</sub> - 1 ml, and a 5% solution of ascorbic acid 1 ml. In addition, for two weeks the dogs received 50,000 units of penicillin every 4 hours, and 0.5 g streptomycin, a complex of vitamins A, B<sub>1</sub>, C, D, E, glucose, and calcium chloride twice daily. Other details of treatment are contained in the text. It was found that in the case of a jaw fracture in conjunction with radiation sickness, teeth on the fracture line cannot be saved in spite of the use of antibiotics. Experiments with bone fragments led to the conclusion that it is better to leave large free fragments in the wound. This prevents the formation of false joints and quickens the healing process in the bone. Fragments in such wounds are best fixed in place with metallic sutures, and tantalum ligatures were found to be best. The use of metallic pins for fixing of fragments is discussed. It was found that if the pins are left in place for a long time, false joints may form, or the wound may not heal properly. Regeneration in the first 7 days was normal. (TCO)

## 3450

THE INFLUENCE OF IONIZING RADIATION ON IMMUNITY. V. L. Troitskii. Voenno-Med. Zhur. No. 2, 53-61(1958).

The effects of radiation on the natural resistance of an organism to certain infectious diseases, largely as observed in laboratory experiments on animals, are discussed. Although the mechanism of this process is only partially understood, many particulars, such as a decrease in the number of leucocytes in the blood, or depression of the phagocyte activity in the reticulo-endothelial system, under the influence of radiation, are known. Other effects of radiation reflected in changes in tissue perviousness, and disturbance of the barrier characteristics are discussed. The influence of total irradiation on the perviousness of the gastric-intestinal tract to toxins of dysentery bacteria was studied. Such irradiation increases the perviousness of the intestine wall to dysentery toxins. The



influence of radiation in lowering the bactericide characteristics of the skin, and in suppressing development of the Schwarzmenn phenomenon are cited as factors which may have significance in lowering the natural resistance of the organism. Radiation effects on the bactericide characteristics of rabbit serum are also discussed. Appearance of bacteria in the blood of irradiated animals, believed to originate in the digestive tract, is also discussed. Autoinfection is a very significant factor in radiation sickness, and it is concluded that even small doses of ionizing radiation can turn latent infection into clinically pronounced infection. The influence of ionizing radiation on the production of antibodies is also treated. Experiments showed that the introduction of antigens to rabbits following irradiation produces only minute quantities of agglutinins, while the ability to produce antibodies is re-established after 3-4 weeks. Reproduction of antitoxic immunity is also dealt with briefly. Experiments also showed that the first phase of antibody formation is radiation-sensitive, while the later phase is radiation-resistant, i.e., radiation applied shortly after immunization tends to slow the process of antibody formation. Thus, once this process is started, it is harmed little even by large doses of radiation. Repeated small doses of radiation, over a long period of time, tend to decrease the harmful effect of a large dose on the formation of antibodies, when immunization follows irradiation. (TCO)

### 3451

SPECIAL FEATURES OF THE COURSE IN INJURIES AND BURNS OF THE EYE, COMPLICATED BY RADIATION DISEASE. B. L. Polyak. Voenno-Med. Zhur. No. 4, 8-11 (1958).

It was experimentally proved that healing of wounds in radiated animals is complicated by the development of a wound infection, especially during the climax period, i.e., 2 to 3 weeks after infection. This fact raised the question whether radiation disease influences also the healing process of wounds and burns of the eye. Based on experiments on rabbits and dogs, it was concluded that the healing of ragged-penetrating injuries of the cornea without surgical treatment takes the same course in radiated rabbits as in the control rabbits and a transparent suture on injuries of the cornea of radiated rabbits, stitched after 24 hours (i.e., in the latent period of the radiation disease) helps to develop the same tight and stable scar as in control experiments. Suture on the cornea may also be successful in patients who were exposed to ionizing radiation. Wound healing after enucleation of an eye of radiated animals did not differ much from healing of wounds in the control rabbits. The prophylaxis and treatment of purulent complications in infected wounds of the eye in radiated animals were also investigated. The data showed that the effectiveness of antibiotics is insufficient, so that the problem of fighting against infections in injuries of the eye, complicated by radiation disease, is to be considered unsolved. Experiments concerning prognosis of thermal burns of the eye in radiation disease showed that second-degree thermal burns of the cornea in radiated rabbits have the same course as those in control animals. In more serious burns, the healing is often accompanied by secondary infections in the burnt cornea, thus sharply aggravating the healing. The effects of blood transfusion as a stimulator of resolving intraocular hemorrhage in contusions or injuries of the eye were studied. Experiments on an experimental hyphema gave evidence of the good healing effect of blood transfusions in radiation disease. Wounds of the palpebra, the conjunctiva and the cornea, infected by radioactive phosphorus have a more serious course than those of non-

infected wounds. It was also shown clinically and pathologically that a sharply pronounced and durable inflammation reaction and hemorrhage in tissues adjacent to the wound with following destruction and atrophy of these tissues is characteristic for infected wounds. In this case surgical treatment prevents further complications. (TCO)

### 3452

ON BURNS OF THE CORNEA IN EXPERIMENTAL RADIATION DISEASE. P. I. Lebekhov. Voenno-Med. Zhur. No. 4, 12-15 (1958).

Burn processes in the tissues of the eye in radiation diseases of different degrees were investigated. Experiments on 41 rabbits were carried out. About 2 to 3 days after radiation, most of the animals reacted with noticeable clinical appearances, such as adynamia, diarrhea, leukopenia, lymphopenia, and food refusal accompanied by a loss in weight. Immediately after the eye had been burnt, and during the following days, the same changes in the eyes of radiated and control animals were observed. Two days later, epithelization started from the edges of the cornea defect and finished after 12 days, completely covering the defect. A secondary infection sharply changed the course of the burn process in both the radiated and the control animals. It was concluded that second-degree thermal burns of the cornea are frequently accompanied by a more serious secondary infection than in usual burns. In moderately-pronounced radiation disease, an infection in the burn's focus was as frequently observed as in control animals. In animals suffering from a first degree radiation disease, the involution of inflamed changes and the regeneration of the epithelium progressed even quicker than in control rabbits. (TCO)

## Radiation Sickness

### 3453 JPRS-L-1110-N

THE TREATMENT OF RADIATION SICKNESS. A. A. Gorodetskii (Gorodetskiy) and Ye. Ye. Chebotarev. Translated from Novyi Khirurg. Arkh., Ukr. S. S. R., No. 4, 3-12 (1959). 16p. OTS.

Procedures are summarized for the treatment of radiation sickness. Data are tabulated on the survival rates of dogs treated by various methods. Results of research on various treatment procedures are discussed. (C.H.)

### 3454 JPRS-L-1956-D

THE USE OF BONE MARROW IN THE COMPOUND TREATMENT OF RADIATION SICKNESS. I. R. Petrov and I. V. Il'inskaya. Translated from Patolog. Fiziol. i Eksptl'. Terap. 3, No. 5, 65-9 (1959). 10p. OTS.

The addition of intraosseous injections of bone marrow from healthy dogs increased the therapeutic effects of other treatments for radiation sickness and led to an 11% reduction in mortality. (C.H.)

### 3455

THE EFFECT OF INCORPORATED RADIOISOTOPES ON THE PERIPHERAL BLOOD PICTURE AND ITS DIAGNOSTIC SIGNIFICANCE. FAST ANALYSIS OF FORMED BLOOD ELEMENTS WITH A NEW AUTOMATIC COUNTER (CONTRIBUTION TO THE EARLY DIAGNOSIS OF RADIATION DAMAGE, ESPECIALLY IN NUCLEAR CATASTROPHES). II. K. Damming and E. H. Graul (Philippsuniversität, Marburg/Lahn, Ger.). Atompraxis 5, 421-5 (1959) Oct.-Nov. (In German)

Radiation damage caused by the incorporation of radioactive substances can be diagnosed by comparing the leucocyte count with the leucocyte resistance value. Early



diagnosis by this method is only possible in cases of lethal doses. Determination of the platelet count and platelet resistance value by means of an electronic counting method makes it possible to diagnose the incorporation of radioactive substances as early as six hours after incorporation in a wide dose range down to one hundredth of the half lethal dose. In the evaluation of internal radiation stress caused by incorporation of radioactive substances the platelet resistance evaluation method is shown to be superior to other relative methods. By means of pulse analysis documentation of cell count as well as cell size is possible within the shortest period. Due to its rapidity this method seems especially suited in case of a catastrophe. (auth)

### 3456

ACCIDENTAL RADIATION EXCURSION AT THE OAK RIDGE Y-12 PLANT. IV. PRELIMINARY REPORT ON CLINICAL AND LABORATORY EFFECTS IN THE IRRADIATED EMPLOYEES. G. A. Andrews, B. W. Sitterson, A. L. Kretchmar, and M. Brucer (Oak Ridge Inst. of Nuclear Studies, Tenn.). *Health Phys.* **2**, 134-8(1959) Oct.

The patients exposed to irradiation in the Y-12 accident were studied and followed at the ORINS Medical Division Hospital. The five patients with the higher dose levels were kept in the hospital for several weeks following exposure. Epilation began on the seventeenth day. Minimal clinical signs of a hemorrhagic tendency were seen around the twenty-fifth to thirtieth days. Antibiotics were not used prophylactically. A few minor infectious episodes occurred, but were easily managed. Hematologic studies showed the characteristic pattern of changes expected after total-body irradiation. Spontaneous recovery of blood values occurred and the patients remained in good general condition following the accident. (auth)

### 3457

MAXIMUM LIKELIHOOD ANALYSIS OF IONIZING RADIATION INDUCED MORTALITY IN WHOLE BODY FRACTIONATED DOSE EXPERIMENTS. J. B. Best (Walter Reed Army Medical Center, Washington, D. C.). *Health Phys.* **2**, 139-56(1959) Oct.

The type of experiment is considered in which a whole body dose of ionizing radiation is acutely administered to a test group of animals; after a specified period of time those still surviving are administered a second such dose. This procedure is repeatable on a number of such test groups using a different dose magnitude and intervals of separation for each group. Three exhaustive time intervals can be considered in which first interval deaths can be ascribed primarily to the first dose, those in the second to the additive effects of the second dose with the residual effect of the first dose, and those not dying until the third interval are considered survivors of the two doses. A mathematical model is derived for the analysis of such data that is a logical extension of the rationale used in the probit analysis of acute single dose data. Injury is postulated to be comprised of two additive components, one permanent and one recoverable. The recoverable injury decrements exponentially with time. Death occurs when the total injury exceeds the lethal threshold of an animal. The logarithm of the lethal thresholds of an animal at two different times is assumed to be bivariate normally distributed with a correlation depending upon the absolute magnitude of the difference between the two times. An iterative calculation procedure is presented for obtaining the maximum likelihood estimates of the relevant parameters and the variances and covariances of these estimates from experimental data of type described above. (auth)

### 3458

THEORETICAL RELATIONSHIP BETWEEN PERCENT KILL AND SHORTENED LIFE SPAN MEASURES OF RADIATION INJURY. J. B. Best (Walter Reed Army Medical Center, Washington, D. C.). *Health Phys.* **2**, 157-64(1959) Oct.

A manner of interpreting kill data is explored in respect to its theoretical implications concerning life-span effects. Although conceived merely as a two dose analogy to the rationale used to interpret single dose kill experiments this postulate introduces the possibility that an animal whose lethal threshold is not exceeded by the maximum injury inflicted during the acute phases following radiation exposure may, at some later time, die by a stochastic transition of its threshold from a value greater to one less than the permanent injury residual from that exposure. This implies that even among those animals which have survived the acute phase, there will occur an increased probability of death per unit time with a subsequent decrease in their mean life-span. This property is a likely consequence of any mathematical model in which a permanent injury component and random variation in time of the lethal threshold of an individual are features of the theory. (auth)

### 3459

ROENTGENOLOGICAL OBSERVATIONS IN INVESTIGATION OF THE LUNGS IN ANIMALS WITH ACUTE RADIATION SICKNESS DUE TO THE ADMINISTRATION OF RADIOACTIVE ISOTOPES. R. M. Rabinovich (Central Scientific Research Inst. of Medical Radiology, Ministry of Health, USSR). *Med. Radiol.* **4**, No. 11, 33-6(1959) Nov. (In Russian)

The author describes roentgenological observations on changes in the pulmonary tissue developing in radiation sickness after the administration of  $P^{32}$  and  $Sr^{90}$ . Twenty guinea pigs and 12 rabbits were under study. The radiation sickness provoked by the intramuscular injection of  $P^{32}$  and  $Sr^{90}$  is attended by changes in the lungs. The latter were manifested in the form of shadows of different size, which alternate with areas of elevated transparency of the lung tissue. Apart from the massive shadows occupying the whole pulmonary field, there were changes very similar to the roentgenological picture of microfocal lesions. The investigations disclosed that hemorrhages in the pulmonary tissue are one of the changes in the lungs detected roentgenologically. (auth)

### 3460

THE CHANGE OF CERTAIN INDICES OF THE FUNCTIONAL STATE OF SKIN VESSELS IN MONKEYS AFFECTED WITH ACUTE RADIATION SICKNESS. V. V. Yukovlev and L. F. Semenov. *Med. Radiol.* **4**, No. 11, 52-6(1959) Nov. (In Russian)

The experiments were staged on 33 monkeys. Under investigation were the systolic arterial pressure, arterial tone, skin temperature, as well as the reaction of the vascular system to a thermal stimulus. The arterial pressure and skin temperature decrease throughout the course of radiation sickness. The tone of arterial vessels rises, the reactivity of vessels to a thermal stimulus drops. (auth)

### 3461

THE EFFECT OF ACS ON THE COURSE OF RADIATION SICKNESS INDUCED WITH RADIOPHOSPHORUS. A. A. Gorodetski (Bogomolets Inst. of Physiology, Academy of Sciences, USSR). *Med. Radiol.* **4**, No. 11, 59-62(1959) Nov. (In Russian)

The author studied the efficacy of antitreticular cytotoxic serum (ACS) on the course of acute radiation sickness in



rats induced by radiophosphorus administration into abdominal cavity. The greatest efficacy was obtained with 5 ACS injection given from the 1st to the 15th day of the disease in a dose of 0.1 ml of the serum diluted in proportion of 1:500 solution. The therapeutic effect was associated with reduced severity of radiation sickness, less pronounced hemorrhagic syndrome, lower degree of hemopoietic system affection and decreased polynuclease activity of the urine. (auth)

**3462**

THE EFFECT OF NATIVE ISOPLASMA TRANSFUSION ON THE COURSE OF ACUTE RADIATION SICKNESS. L. S. Rogacheva (Inst. of Hematology and Blood Transfusion, Ministry of Health, USSR). *Med. Radiol.* **4**, No. 11, 62-6(1959) Nov. (In Russian)

The author investigated the efficacy of native isoplasma transfusions against the background of complex therapy in dogs subjected to total irradiation in the dose of 700 to 800 r (LD<sub>50</sub>). As demonstrated, numerous native plasma transfusions conducted at various periods of radiation sickness appeared to be an effective means of treating acute radiation sickness. Native plasma, probably, has a favorable effect on hemopoiesis and possesses disintoxicating properties. (auth)

**3463**

INTRADERMAL TESTS WITH DISTILLED WATER IN IRRADIATED DOGS. N. N. Klemparskaya and N. V. Raeva. *Med. Radiol.* **4**, No. 11, 71-4(1959) Nov. (In Russian)

A simple test has been suggested for detection of increased sensitivity to the disintegration products of own tissues by intradermal injection of sterile distilled water (0.5 ml). Only a mild hyperemia, disappearing in 1 to 2 days occurs at the site of injection in healthy dogs during the first 5 to 7 days after the irradiation with the lethal dose of filtered x rays. Beginning from the 10th day after the irradiation the intradermal distilled water injections provoke edema and hemorrhages 18 to 24 hours after the injection. Administration of the same volume of physiological saline at that period caused no visible reaction. (auth)

**3464**

THE INFLUENCE OF BLEEDING ON THE ERYTHROPOIESIS IN RADIATION SICKNESS. L. L. Shepshelovich. *Med. Radiol.* **4**, No. 11, 77-81(1959) Nov. (In Russian)

A review is presented on the influence of bleeding on the erythropoiesis in radiation injuries. (R.V.J.)

**3465**

SERUM IMBALANCES IN RATS 24 TO 96 HOURS AFTER EXPOSURE TO X-IRRADIATION. W. G. Glenn (School of Aviation Medicine, Randolph AFB, Tex.). *Radiation Research* **11**, 804-9(1959) Dec.

An agar column diffusion method together with direct photometric quantitation was used to detect statistically significant changes in the diffusion of precipitin zones in rat sera. Zones of precipitation associated with albumin, globulin(s), and mucoproteins were measured. In addition to a control group, serum samples were taken from each animal before exposure. The animals were exposed to 500 r and 400 r of whole-body X irradiation and sacrificed at 24-hour intervals. Disproportional changes in the serum components were found, beginning with the first post-irradiation bleeding (24 hours) and increased up to 72 hours. Imbalances were slightly less at 96 hours postirradiation. The quantitative application of the agar column immunochemical technique to irradiation studies of rats is believed to indicate a new horizon. Some advantages of the method over others generally used

are discussed. Considerations for finding valid changes in diffusion studies are also mentioned. (auth)

**3466**

EFFECT OF POST-IRRADIATION BONE MARROW TREATMENT ON RAT SPLEEN NUCLEIC ACIDS. R. M. Iammarino and M. Berenbom (Univ. of Kansas, Kansas City). *Radiation Research* **11**, 820-4(1959) Dec.

A study has been made of the ability of rat bone marrow, given to rats 1 to 2 hours after 400 r of whole-body x irradiation, to prevent or correct previously observed changes in the weight, RNA content, DNA content, and DNA purine-pyrimidine composition of spleen. There was no evidence of prevention of these changes as determined 2 days after irradiation, but there was a slight beneficial effect on recovery as determined at 7 days by the significantly larger values for spleen weight, RNA content, and DNA content in irradiated rats which received bone marrow than in those which did not receive this treatment. Bone marrow given to irradiated rats did not prevent or correct the changes in the purine-pyrimidine composition of spleen DNA, which follow 400 r of whole-body x irradiation. (auth)

**3467**

DARK ADAPTATION IN FIRST-DEGREE RADIATION DISEASE. N. N. Bokhon. *Voenno-Med. Zhur.* No. 4, 15-16 (1958).

It was shown experimentally that radiation disease changes the vitamin balance, and disturbs the metabolism and the life activity of certain organic systems, especially of the central nervous system. Dark adaptation of the eyes was examined in patients to be treated with x rays. The data show that in all persons the adaptation curve was within the zone of the norm. This does not exclude an eventual reduction of the adaptation dependent on the degree of the radiation disease. In the first degree of radiation disease, the state of dark adaptation as a rule does not change. (TCO)

**CHEMISTRY****General and Miscellaneous****3468 AD-214587**

Dow Chemical Co. Thermal Lab., Midland, Mich. THERMODYNAMIC PROPERTIES OF COMBUSTION PRODUCTS. G. C. Sinke. Apr. 1, 1959. 150p. Contract AF33(616)-6149. (AR-1S-59).

Data on thermodynamic properties of propellants are tabulated. The tables are considered neither definitive nor exhaustive. The data were obtained by integration of quadratic equations, fitting the heat capacities at three successive 100° intervals. Values for entropy and heat content may therefore vary from cited sources. It is thought that the method gives a high degree of internal consistency. The tables cover elements 1 through 17, excluding He and Ne. (J.R.D.)

**3469 AECU-4504**

Utah. Univ., Salt Lake City. Inst. for the Study of Rate Processes.

THE ELECTROCHEMICAL THEORY OF SMELTING AND RELATED REACTIONS. Technical Report No. 36.

Xavier de Hemptinne, Henry Eyring, and Taikyue Ree. Nov. 9, 1959. 43p. Project No. 1. Contract AT(11-1)-82. OTS.

The potentials and electrical current flowing at an interface between two phases as a result of chemical reactions

which promote selective ion migration are examined. Results from related fields are used as a basis of understanding. Included are discussions of multi-barrier diffusion, diffusion of charged particles in an electric field, migration of ions through a uniform membrane, and effects of voltage changes in diffusion rates. Processes in which the diffusion of ions is coupled with an irreversible chemical reaction such as desulfurization of iron, photographic development, and corrosion. (J.R.D.)

**3470 AERE-C/R-2472(Pt. 1)**

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

ABSTRACTS OF ATOMIC ENERGY PROJECT UNCLASSIFIED REPORTS AND PUBLISHED LITERATURE ON THE ACTINIDE ELEMENTS. (PAPERS DATED 1957 NOTED UP TO FEBRUARY 1958). PART I. ACTINIUM, PROT-ACTINIUM, NEPTUNIUM. R. W. Clarke, comp. Feb. 1958. 20p. BIS.

Abstracts of reports and published literature on Ac, Pa, and Np, dated January 1957 and onward are presented. One section comprises abstracts of American, Canadian, British, and other unclassified Atomic Energy project reports arranged alphabetically, while a second section consists of abstracts of published literature arranged alphabetically by first named author. Author and subject indexes are also provided. (W.L.H.)

**3471 AERE-C/R-2472(Pt. 2)**

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

ABSTRACTS OF ATOMIC ENERGY PROJECT UNCLASSIFIED REPORTS AND PUBLISHED LITERATURE ON THE ACTINIDE ELEMENTS. (PAPERS DATED 1957 NOTED UP TO APRIL 1958). PART 2. THORIUM. R. W. Clarke, comp. May 1958. 58p. BIS.

Abstracts of reports and published literature on thorium, dated January 1957 and onward are presented. One section comprises abstracts of American, Canadian, British, and other unclassified Atomic Energy project reports arranged alphabetically, while a second section consists of abstracts of published literature arranged alphabetically by first named author. Author and subject indexes are also provided. (W.L.H.)

**3472 AERE-C/R-2472(Pt. 4)**

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

ABSTRACTS OF ATOMIC ENERGY PROJECT UNCLASSIFIED REPORTS AND PUBLISHED LITERATURE ON THE ACTINIDE ELEMENTS. (PAPERS DATED 1957 NOTED UP TO MARCH 1958). PART 4. PLUTONIUM. R. W. Clarke, comp. Apr. 1958. 64p. BIS.

Abstracts of reports and published literature on plutonium, dated January 1957 and onward are presented. One section comprises abstracts of American, Canadian, British, and other unclassified Atomic Energy project reports arranged alphabetically, while a second section consists of abstracts of published literature arranged alphabetically by first named author. Author and subject indexes are also provided. (W.L.H.)

**3473 AERE-C/R-2472(Pt. 5)**

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

ABSTRACTS OF ATOMIC ENERGY PROJECT UNCLASSIFIED REPORTS AND PUBLISHED LITERATURE ON THE

ACTINIDE ELEMENTS. (PAPERS DATED 1957 NOTED UP TO FEBRUARY 1958). PART 5. TRANS-PLUTONIUM ELEMENTS. R. W. Clarke, comp. Mar. 1958. 31p. BIS.

Abstracts of reports and published literature on trans-plutonium elements, dated January 1957 and onward are presented. One section comprises abstracts of American, Canadian, British, and other unclassified Atomic Energy project reports arranged alphabetically, while a second section consists of abstracts of published literature arranged alphabetically by first named author. Author and subject indexes are also provided. (W.L.H.)

**3474 AERE-C/R-2472(Pt. 6)**

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

ABSTRACTS OF ATOMIC ENERGY PROJECT UNCLASSIFIED REPORTS AND PUBLISHED LITERATURE ON THE ACTINIDE ELEMENTS. (PAPERS DATED 1957 NOTED UP TO JULY 1958). PART 6. GENERAL PAPERS. R. W. Clarke, comp. Aug. 1958. 13p. BIS.

Abstracts of reports and published literature on actinide elements, dated January 1957 and onward are presented. One section comprises abstracts of American, Canadian, British, and other unclassified Atomic Energy project reports arranged alphabetically, while a second section consists of abstracts of published literature arranged alphabetically by first named author. Author and subject indexes are also provided. (W.L.H.)

**3475 CF-57-6-6**

Oak Ridge National Lab., Tenn.  
SPECIFICATIONS FOR CLEANLINESS REQUIREMENTS; HIGH LEVEL VOLATILITY LAB. 4507. J. B. Ruch. June 6, 1957. 4p. OTS.

Specifications are presented for cleanliness during installation of piping and equipment in the High Level Volatility Laboratory, Bldg. 4507. (J.R.D.)

**3476 CF-59-11-64**

Oak Ridge National Lab., Tenn.  
LIQUID-LIQUID IMMISCIBILITY ABOVE 300°C IN THE SYSTEM  $\text{UO}_3\text{-SO}_3\text{-N}_2\text{O}_5\text{-H}_2\text{O}$ . C. J. Barton, G. M. Herbert, and W. L. Marshall. Nov. 17, 1959. 23p. OTS.

Newly developed fused-salt-bath apparatus currently in use for the observation of liquid-liquid immiscibility in solutions sealed in silica tubes is described. Immiscibility temperatures are reported for 0.04, 0.08, and 0.16 molal  $\text{UO}_3^{++}$  solutions in the system  $\text{UO}_3\text{-SO}_3\text{-N}_2\text{O}_5\text{-H}_2\text{O}$ . A comparison of the effect of nitric and sulfuric acids on the immiscibility temperature of uranyl sulfate solutions on the basis of total added  $\text{H}^+$  concentration showed that at low acidity nitric acid produced a greater increase in immiscibility temperature than sulfuric acid and at high acidity sulfuric acid became more effective than nitric acid. In solutions containing low concentrations of excess acid, the substitution of nitrate for sulfate raised the immiscibility temperature, but at high acidities the initial substitution lowered the immiscibility temperature. The data seem to indicate that there is an interdependence between acidity and complexing in this system. The data also show that there is some advantage in using mixed nitrate-sulfate anions in uranyl solutions as compared to solutions containing only sulfate/anions for the purpose of raising the immiscibility temperature of sulfate-based aqueous homogeneous reactor fuels. If the addition of  $\text{NO}_3^-$  to  $\text{UO}_2\text{SO}_4\text{-H}_2\text{SO}_4\text{-H}_2\text{O(D}_2\text{O)}$  solutions markedly reduces corrosion on metal surfaces by the fuel and also raises the immiscibility temperature, then there may be applied uses for aqueous homogeneous reactors. (auth)



**3477** NAA-ER-3940

Atomics International Div., North American Aviation, Inc.,  
Canoga Park, Calif.

THE SOLUBILITY OF SALTS IN METALS. S. J. Yosim  
and E. B. Luchsinger. Aug. 1, 1959. 15p. Contract AT-  
11-1-GEN-8. OTS.

A series of experiments to determine the solubilities of metal chlorides in their metals was carried out using a visual technique. The systems studied included Bi, Hg, Pb, Cd, Zn, Sn, In, Ag, and Cu with their chlorides. The results show that  $\text{BiCl}_3$  and  $\text{Hg}_2\text{Cl}_2$  are most soluble, the former being completely miscible with Bi at  $778^\circ\text{C}$ , while the latter is soluble to the extent of 7 mole % at  $600^\circ\text{C}$ .  $\text{PbCl}_2$  is slightly soluble (1 mole % at  $1,000^\circ\text{C}$ ), while the remaining salts are considered insoluble in their metals. There does not appear to be any single criterion for predicting the solubility of salts in their metals. Experiments were also carried out to see if nonspecificity of solubility exists at high temperatures—i.e., to determine if metals dissolve salts other than their own halides. It was found that solubility does occur. It was also found that the less stable the salt, the greater is the solubility of the salt in a given metal, until the solubility approaches that of the salt of the metal. Thermodynamic calculations indicate that the solubility of a foreign salt in a metal can be explained in terms of oxidation-reduction reactions to form the halide of the metal, which in turn dissolves in the metal. These calculations suggest that  $\text{BiCl}_3$  dissolves in bismuth metal as  $\text{BiCl}$ . (auth)

**3478** NP-8079

Olin Mathieson Chemical Corp. Specialty Chemicals Research Energy Div., New Haven.

SYNTHESIS OF NITROGEN-CONTAINING HETEROCYCLIC FLUID SYSTEMS. Quarterly Progress Report No. 2 [for] Period August 15, 1959 to November 14, 1959. E. H. Kober. 30p. Project No. 9(8-7023). Contract AF33(616)-6342.

Suitable techniques for the preparation of substituted melams and intermediates were studied on the syntheses of a number of secondary aromatic amines, substituted s-triazines, and derivatives of melam. During the first phase of the investigations it had already been shown that the two lowest members of the series of polyphenylmelams, nonaphenyl-melam (I) and 2-diphenylamino-4,6-bis-(phenylmelamino-s-triazine (II)), exhibited besides excellent thermal stability very high melting points. Therefore, in the second phase of this project several approaches were started to lower the melting point of these compounds by replacing phenyl groups with methyl, benzyl, or methyl-substituted phenyl groups. Three representatives of N,N-phenylmethyl-substituted melams are described. It is shown that the replacement of four phenyl groups of compounds I or II by methyl groups results in a considerable decrease of the melting points. Several intermediates were prepared for the synthesis of N-benzyl-substituted melams and of melams bearing methyl-substituted phenyl groups. As in the field of substituted melams, investigations in the class of condensed triazine systems were mainly concerned with the synthesis of compounds having lower melting points than those already prepared. It is shown that methyl-substituted aryl-cyamelurates have even higher melting points than tris-phenyl-cyamelurate and that liquid derivatives of tris-phenyl-cyamelurine cannot be obtained solely by methyl-substitution of the phenyl rings, although lower melting points were achieved by this approach. It was found that ethyl-substituted triphenyl-cyamelurines show considerably lower melting points than tris-phenyl-cyamelurine, the parent compound of this class of compounds. (auth)

**3479** NP-8090

Florida. Univ., Gainesville.

THE SYNTHESIS OF UNSATURATED FLUOROCARBONS. Quarterly Report No. 33 for June 13, 1959–September 13, 1959. Paul Tarrant, Ronald D. Richardson, David E. O'Connor, and Eugene C. Stump, Jr. 22p. Project No. 7-93-15-004. Contract DA-19-129-QM-500.

Samples of  $\text{CF}_2 = \text{CHCH}_2\text{OC}_2\text{H}_5$ ,  $\text{CF}_2 = \text{CHCH}_2\text{OCH}_2\text{CF}_3$ , and  $\text{CF}_2 = \text{CFCH}_2\text{CH}_2\text{OC}_2\text{H}_5$  were prepared.  $\text{C}_3\text{F}_7\text{NO}$  was obtained from  $\text{C}_3\text{F}_7\text{COOAg}$  by reaction with  $\text{NOCl}$ . Attempts to dehalogenate  $\text{CF}_2\text{ClCFClNO}$  were unsuccessful.  $\text{CF}_2\text{CCl} = \text{CClCF}_3$  was reacted with isoprene and  $\text{CH}_2 = \text{C}(\text{CF}_3) - \text{CH} = \text{CH}_2$  to yield cyclohexene derivatives. Vinylmethylfluoroalkylcarbinols have been prepared where  $\text{R}_f = \text{CF}_3$ ,  $\text{C}_2\text{F}_5$ , and  $\text{C}_3\text{F}_7$ . (auth)

**3480** NRL-5384

Naval Research Lab., Washington, D. C.

LOW-HAZARD LININGS FOR STEEL FUEL STORAGE TANKS. J. R. Griffith, J. E. Cowling, and A. L. Alexander. Aug. 4, 1959. 29p.

The ever-increasing demand for higher quality and cleaner fuels for modern engines of war and the desirability of using existent steel fuel storage tanks has required the application of protective interior coatings to these tanks. A wide range of organic film-forming polymers was evaluated; the results indicate that carefully formulated urethane coatings are superior to all other types currently available for use as linings for steel fuel storage tanks. It was determined that the serviceable life of organic coatings can be greatly extended by their application over flame-sprayed aluminum. Further, an organic coating applied as a sealer to flame-sprayed aluminum will seal minor leaks, such as pores in welds, against pressures up to 200 psi. Progress was made in the development of noncombustible thinners for use in applying organic coatings in confined spaces. Relatively small quantities of halogenated diluents will often eliminate flashing of a normal hydrocarbon paint thinner. The most effective diluents are those containing a substantial amount of fluorine in the molecule. (auth)

**3481** WCAP-567

Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh and Pennsylvania Power and Light Co. Atomic Engineering [Dept.], Pittsburgh.

HEAT OF RECOMBINATION AND RECOMBINER EXIT TEMPERATURE. D. F. Rinald. June 15, 1957. 6p. OTS.

Methods of calculating the heat of recombination of deuterium and oxygen are described. In addition methods of calculating the recombiner exit temperature are described and data on these temperatures as a function of inlet  $\text{D}_2$  concentration are presented. (J.R.D.)

**3482** WCAP-569

Westinghouse Electric Corp., Atomic Power Dept., Pittsburgh and Pennsylvania Power and Light Co. Atomic Engineering [Dept.], Pittsburgh.

DESIGN AND OPERATION OF A CATALYTIC RECOMBINER. D. F. Rinald. June 15, 1957. 13p. OTS.

The  $\text{D}_2\text{O}$  coolant-moderator of the PAR is dissociated by the fissioning uranium. The deuterium and oxygen gases evolved from the reactor are recombined in an external catalytic bed in order to recover the heavy water. This report discusses the design considerations for catalytic recombiners and outlines a method for calculating the important bed parameters. (auth)

**3483** WCAP-685

Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh and Pennsylvania Power and Light Co. Atomic Engineering [Dept.], Pittsburgh.

THE PROPERTIES OF THORIA-HEAVY WATER SLURRIES. PART I. APPARENT DENSITY, HEAT CAPACITY AND THERMAL CONDUCTIVITY OF THE  $\text{ThO}_2\text{-D}_2\text{O}$  SLURRIES. R. J. Atkins, G. R. Taylor, and E. H. Shin. Sept. 30, 1957. 15p. OTS.

3484 WCAP-913

Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh and Pennsylvania Power and Light Co. Atomic Engineering Dept., Pittsburgh.

THE INTERMEDIATE DENSITY FLOAT APPARATUS FOR DETERMINING SETTLING RATES OF THORIA-URANIA SLURRIES IN THE RANGE 30-300°C. G. Kivenson and W. E. Foster. June 15, 1958. 23p. OTS.

A simple method for measuring the settling rates of slurries at elevated temperatures and pressures is described. The useful ranges of the method, its limitations, and typical test results for thoria-uranium slurries are presented. (auth)

3485 AEC-tr-3680

THE REACTIONS OF NITROGEN IN EXPLOSIONS. A. Y. Apin, Yu. A. Lebedev, and O. I. Nefedova. Translated for Los Alamos Scientific Lab. from *Zhur. Fiz. Khim.* 32, 819-23(1958). 7p. JCL or LC.

The interactions of nitrogen in explosions are examined. Calorimetric data on the heats of explosions were obtained in runs with hexogen, lead azide, hydrazine azide, and mixtures of these with some metals. It was found that ammonia is formed in the explosion of hydrazine azide, due to the reaction of N with H, and when mixtures of hexogen with Al and Be are exploded, heat is produced by reaction of N with the metal. (J.R.D.)

3486 AEC-tr-3682

COPRECIPITATION OF LANTHANUM, CERIUM, AND AMERICIUM WITH POTASSIUM SULFATE. V. I. Grebenshchikova and V. N. Bobrova. Translated for Los Alamos Scientific Lab. from *Zhur. Neorg. Khim.* 3, 40-5(1958). 10p. JCL or LC.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 13,805.

3487 AEC-tr-3897

CHANGE OF ANODE POTENTIAL OF A CALOMEL ELECTRODE IN ELECTROLYSIS. Hisao Hayakawa. Translated for Los Alamos Scientific Lab. from *Bunseki Kagaku* 8, 456-7(1959). 4p. JCL.

The saturated calomel electrode is widely used as the standard electrode for measurement of potential, and has been recently used as reference electrode in polarography and amperometric titration. It can be used as the opposite pole in electrolysis. It is observed that the saturated calomel electrode can also be used as anode in electrolysis with a definite bath potential, provided its potential remains stable. Therefore, electrolysis with a limited cathode potential could be done without the use of a reference electrode. The stability of the potential was tested by passing current through the saturated calomel electrode. The apparatus shown was used in the experiment for electrolysis of a copper-EDTA solution. (auth)

3488 CEA-tr-R-623

ETAT DE MICROQUANTITES DE RADIOELEMENTS EN PHASE LIQUIDE ET EN PHASE SOLIDE. (State of Microquantities of Radioelements in the Liquid and Solid Phases). I. E. Starik. Translated into French from *Zhur. Neorg. Khim.* 3, 6-15(1958). 27p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 13729.

3489 NP-tr-314

ELECTROKINETICS OF LIQUID METALS. A. Klemm. Translated by A. H. Turnbull. (U.K.A.E.A. Atomic Energy Research Establishment) from *Z. Naturforsch.* 13a, 1039-43(1958). 14p. JCL. (Handwritten MS.)

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, as abstract No. 5312.

3490 NP-tr-320

THE PHOTOCATALYTIC ACTIVATION OF ZINC OXIDE. A. V. Pamfilov, R. Ya. Mushil, and Ya. S. Mazurkevich. Translated by R. W. Hummel (U.K.A.E.A. Atomic Energy Research Inst. of Physics and Chemistry). *Doklady Akad. Nauk S.S.S.R.* 128, 1214-16(1959) Oct. 21. (In Russian)

The photocatalytic activity of pure ZnO increases with the addition of Bi, Ag, and Cu. The activator efficiency varies in the order Bi > Ag > Cu. Copper put into an active commercial preparation of ZnO decreases its activity. (auth)

3491

EQUILIBRIUM DISTRIBUTION OF DEUTERIUM ON HYDROGEN EXCHANGE WITH LIQUID IODIC DEUTERIUM. P. P. Alikhanov and J. M. Varshavskii (Karpov Scientific Research Inst. of Physics and Chemistry). *Doklady Akad. Nauk S.S.S.R.* 128, 1214-16(1959) Oct. 21. (In Russian)

The equilibrium in deuterium exchange reactions with HI is studied using the aromatic C-H bond-HI as the example. (R.V.J.)

3492

VARIATION OF ADSORPTIVE PROPERTIES OF SILICA GEL UNDER THE ACTION OF GAMMA RAYS. S. V. Starodubtsev, Sh. A. Abilaev, and S. E. Ermatov. *Doklady Akad. Nauk S.S.S.R.* 129, 72-3(1959) Nov. 1. (In Russian)

Investigations of the effects of  $\text{Co}^{60}$   $\gamma$  rays on the sorptive properties of silica gels indicate a considerable increase in sorption with irradiation up to a certain limit. It is assumed that the changes in sorptive properties are caused by a break in the hydroxide group and the formation of free valences on the surface. (R.V.J.)

3493

CONTAINMENT OF RADIOACTIVE FISSION GASES BY DYNAMIC ADSORPTION. Robert E. Adams, William E. Browning, Jr., and Robert D. Ackley (Oak Ridge National Lab., Tenn.). *Ind. Eng. Chem.* 51, 1467-70(1959) Dec.

The release of radioactive fission product gases from a circulating fuel nuclear reactor is of such magnitude that direct disposal into the atmosphere is prohibited. A method for disposal of these gases was developed. The fission gases, krypton and xenon, are absorbed from a carrier gas stream onto the surface of a porous adsorbent. Although the adsorption process is reversible, it effectively hinders the passage of fission gases through the system while radioactive decay continually reduces the concentration. Operating parameters which affect the adsorption processes were studied, and the data obtained were found applicable for the design of future systems. (auth)

3494

RUTHENIUM(III) GLUCONATE COMPLEXES. Donald T. Sawyer, Raymond S. George, and John B. Bagger (Univ. of California, Riverside). *J. Am. Chem. Soc.* 81, 5893-9(1959) Nov. 20.

An investigation of polarographic methods for the determination of ruthenium led to a systematic study of the complexes of ruthenium(III) with the gluconate ion. A reversible polarographic wave, which is independent of pH and gluconate ion concentration, is obtained above pH 13 for the reduction of ruthenium(III). In 0.2 F sodium gluconate at pH 14 the reduction wave has a half-wave po-



tential of  $-0.67$  v vs. S.C.E. and a diffusion current constant of 1.17. When an excess of ruthenium(III) is added to a basic gluconate solution, soluble polymers are formed initially which have a molar ratio of metal to gluconate of approximately 6. The polymers hydrolyze slowly to give ruthenium oxide and a stable complex with a molar ratio of one ruthenium(III) per gluconate ion. Spectrophotometric studies of this stable complex indicate that there are two forms, one from pH 3.5 to 7.5 and a second above pH 8. The second form of the complex follows Beer's law when a ten-fold excess of gluconate ion is present and the pH is 14. The molar absorptivity is 4170 at 337 m $\mu$ . In basic gluconate solutions ruthenium(II) and ruthenium(III) exhibit a complex set of equilibria which were studied polarographically. Reaction mechanisms are proposed for the equilibria on the basis of the polarographic studies. (auth)

### 3495

PHOTOLYSIS OF URANYL SULPHATE AND ISOLATION OF URANIUM(IV) OXYSULPHATE. Balaram Sahoo and D. Patnaik (Utkal Univ., Cuttack, India). *J. Indian Chem. Soc.* **36**, 483-5(1959) July.

An aqueous solution of uranyl sulfate with half its volume of formic acid and absolute alcohol on exposure to sunlight undergoes photolysis, and a bright green hydrated uranium(IV) oxysulfate  $\text{UOSO}_4 \cdot 3.3 \text{H}_2\text{O}$  is precipitated. On heating this aquo-oxysulfate at 150 to 160°C in vacuum for 3 to 4 hours, the anhydrous compound is obtained. (auth)

### 3496

TEMPERATURE DEPENDENCE OF SOME CATION EXCHANGE EQUILIBRIA IN THE RANGE 0 TO 200°. Kurt A. Kraus and Richard J. Raridon (Oak Ridge National Lab., Tenn.). *J. Phys. Chem.* **63**, 1901-7(1959) Nov.

The temperature dependence of a number of cation-exchange equilibria (tracers of  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Rb}^+$ ,  $\text{Cs}^+$ ,  $\text{Be}^{++}$ ,  $\text{Ba}^{++}$ ,  $\text{Co}^{++}$ ,  $\text{Zn}^{++}$ ,  $\text{La}^{+3}$ ,  $\text{Eu}^{+3}$  vs.  $\text{H}^+$ ; tracers of  $\text{K}^+$ ,  $\text{Rb}^+$ ,  $\text{Cs}^+$  and  $\text{Ba}^{++}$  vs.  $\text{Na}^+$ ) was studied in dilute aqueous electrolyte solutions. The temperature range was 0 to 150° for exchanges with the  $\text{H}^+$ -form of the resin and 0 to 200° for those with the  $\text{Na}^+$ -form. The upper temperature limits were imposed by the stability of the resin ( $\text{H}^+$ -form) and the "safe" operating range of the equipment ( $\text{Na}^+$ -form). Apparent heat ( $\Delta\bar{H}^\circ$ ), entropy ( $\Delta\bar{S}^\circ$ ) and heat capacity ( $\Delta\bar{C}_p^\circ$ ) changes were computed for the ion-exchange equilibria. In all cases  $\Delta\bar{C}_p^\circ$  was positive; in a few cases it was quite large (up to 20 cal/deg/equiv.). Good agreement between calculated and observed selectivity coefficients could be obtained by assuming  $\Delta\bar{C}_p^\circ$  to be constant which leads to a linear variation of  $\Delta\bar{H}^\circ$  with temperature T, and of  $\Delta\bar{S}^\circ$  with log T. In many cases  $\Delta\bar{H}^\circ$  becomes zero in or near the temperature range studied (minima in the selectivity coefficient vs. temperature curves); this appears to be one reason why values of  $\Delta\bar{H}^\circ$  for ion-exchange reactions are often small. (auth)

### 3497

THE KINETICS OF POLYMERIZATION OF  $\alpha$ -VINYLNAPHTHALENE. S. Loshaek, Edward Broderick, and Philip Bernstein (Borden Chemical Co., Philadelphia). *J. Polymer Sci.* **39**, 223-39(1959) Sept.

The kinetics of the 2,2'-azobisisobutyronitrile-initiated bulk polymerization of  $\alpha$ -vinylnaphthalene (AVN) at 50, 60, and 70°C is reported. The polymerization rate is proportional to the  $1/2$  power of the initiator concentration and the first power of the monomer concentration. The ratio of the termination rate constant to the square of the propagation rate constant is slightly less than for styrene. Unlike styrene, however, very low molecular weight polymers (~2000 to 6000) are obtained throughout the entire conver-

sion of monomer to polymer. The molecular weight is shown to be controlled by a chain transfer reaction with the monomer, the value of the transfer constant being about 0.03 at 50, 60, and 70°C, about 300 times that of the monomer, transfer constant for styrene. The transfer reaction is attributed to an attack of a growing polymer radical on the naphthalene ring of the AVN. In support of this, the transfer constant of the polystyryl radical with naphthalene was also found to be large ( $1.1 \times 10^{-3}$ ), about 600 times that of the transfer constant ( $1.86 \times 10^{-6}$  at 60°C) of the same radical with benzene. A transfer constant of similar magnitude was obtained for the polynaphthalyl radical with naphthalene. This greater polystyryl radical affinity for naphthalene over benzene is in excellent agreement with expectations based on methyl radical affinities for these same substrates. The greater value of the monomer transfer constant of AVN over that of the polynaphthalyl or polystyryl radicals with naphthalene suggests an activation of the naphthalene ring in AVN. The differences in the polymerization kinetics of AVN and vinyl benzoate are discussed. The over-all second-order thermal rate constant for AVN is found to be about eight times that for styrene at the same temperature. Over-all activation energies of 21.5 and 17.4 kcal/mole are obtained for the initiated and purely thermal polymerizations, respectively. An empirical intrinsic viscosity-molecular weight relation for AVN polymer is given. (auth)

### 3498

REACTIVITY RATIOS AND RATES IN THE COPOLYMERIZATION OF  $\alpha$ -VINYLNAPHTHALENE AND STYRENE. S. Loshaek and Edward Broderick (Borden Chemical Co., Philadelphia). *J. Polymer Sci.* **39**, 241-7(1959) Sept.

Copolymerization reactivity ratios at 60°C for  $\alpha$ -vinylnaphthalene (AVN) and styrene were found to be  $r_1 = 1.35$  and  $r_2 = 0.67$ , respectively, from which Price Q and e values for AVN of 1.15 and 0.49 were calculated. From these Q and e values and those published previously for 4-chloro-1-vinylnaphthalene, styrene, and p-chlorostyrene it is shown that the chlorine atom has a very similar electronegative effect in both the styrene and AVN rings. Initial rates of copolymerization at 60°C with 2,2'-azobisisobutyronitrile as initiator were determined over the entire composition range from pure AVN to pure styrene. The rate data are shown to be consistent with a value of 3 for  $\phi$ , the cross-termination rate constant. (auth)

### 3499

A STRUCTURAL MODEL FOR MONATOMIC LIQUIDS INCLUDING METALLIC LIQUIDS. Kazuo Furukawa (Tohoku Univ., Sendai). *Nature* **184**, 1209-10(1959) Oct. 17.

A structural model is presented for monatomic liquids including metallic liquids. The coordination numbers (Z), the distance (r) of the nearest neighbor, and bulk density are calculated for 18 elements assuming a quasi face-centered cubic lattice and compared to observed values. (C.J.G.)

### 3500

HALOGEN NUCLEAR MAGNETIC RESONANCE SHIFTS. PART I.  $\text{Cl}^{35}$  RESONANCE IN ALKALI CHLORIDES.

Putchá Venkateswarlu and B. D. Nageswara Rao (Muslim Univ., Aligarh, India). *Proc. Indian Acad. Sci., Sec. A* **50**, 254-8(1959) Oct.

The nuclear magnetic resonance shifts of  $\text{Cl}^{35}$  in aqueous solutions of alkali chlorides were determined using a high resolution NMR spectrometer. These small shifts probably represent the effect of the neighboring atom even in the highly ionic state. A similarity of these results to the quadrupole coupling constants of the halogen atom in these molecules in gaseous phase is pointed out. (auth)

## 3501

THE REACTION BETWEEN CERIU (III) AND COBAL (III). PART 2. THE EFFECT OF NITRATE AND OF FLUORIDE IONS. L. H. Sutcliffe and J. R. Weber (The University, Liverpool). *Trans. Faraday Soc.* 55, 1892-9 (1959) Nov.

A study of the Co(III) + Ce(III) reaction was made to investigate the influence of nitrate and fluoride ions. Although fluoride ions produce a much more marked acceleration of the reaction rate than do nitrate ions, both appear to participate in similar mechanisms. From spectrophotometric investigation the heat and entropy of formation of  $\text{CeNO}_3^{2+}$  were found to be  $-7 \pm 2$  kcal mole<sup>-1</sup> and  $-23 \pm 7$  cal mole<sup>-1</sup> deg.<sup>-1</sup> respectively at 25°C for an ionic strength of 1.0 M. Using these data the true energy and entropy of activation of the nitrate-accelerated path were calculated to be  $14 \pm 2$  kcal mole<sup>-1</sup> and  $-5 \pm 1$  cal mole<sup>-1</sup> deg.<sup>-1</sup> respectively at 25°C for an ionic strength of 1.0 M. (auth)

## 3502

ELECTRODE REACTIONS IN MOLTEN SALTS: THE URANIUM + URANIUM TRICHLORIDE SYSTEM. D. Inman and J. O'M. Bockris (Univ. of Pennsylvania, Philadelphia); and G. J. Hills (Imperial Coll., London); and L. Young (Univ. of British Columbia, Vancouver). *Trans. Faraday Soc.* 55, 1904-14 (1959) Nov.

The emf of the cell:  $\text{U}|\text{UCl}_3, \text{LiCl} + \text{KCl}|\text{KCl} + \text{LiCl}, \text{AgCl}|\text{Ag}$  under conditions of thermodynamic reversibility and current flow was measured as a function of uranium trichloride concentration, temperature, current density, and time over the temperature range 440 to 540°C. The thermodynamic parameters of the uranium electrode reaction were evaluated and used to obtain corresponding data for the complexing of the uranium ion in this chloride eutectic. Uranium metal was deposited at ~100% current efficiency for the process  $\text{U}^{3+} + 3e \rightarrow \text{U}$ . Current-potential and potential-time curves corresponded to a primary cathodic deposition process. This occurred only after an induction period, the length of which was dependent on the degree of stirring of the melt. The primary product was dendritic uranium metal but if the limiting current corresponding to the uranium concentration was exceeded, a finely divided product was also produced from the secondary reduction process involving alkali metal. (auth)

## 3503

TRITIUM-LABELED DEOXYRIBONUCLEIC ACID. Ellen Borenfreund, Herbert S. Rosenkranz, and Aaron Bendich (Cornell Univ. Medical Coll., New York). p.130-4 of "The Kinetics of Cellular Proliferation." New York, Grune and Stratton, 1959.

The effect of tritium incorporation into DNA, isolated from human leukocytes, was investigated. A comparison with the untritiated sample revealed a drop in average sedimentation coefficient from 19.3 S to 11.4 S, and in number average molecular weight from  $5.2$  to  $1.3 \times 10^6$ . Chromatography on cellulose columns gave rise to elution patterns, which seem to corroborate the changes observed by ultracentrifugation. These changes were not accompanied by denaturation. The use of tritiated DNA for metabolic studies is discussed. (auth)

## Analytical Procedures

## 3504 AAEC/E-39

Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales.  
A SPECIFIC METHOD FOR THE DETERMINATION OF

URANIUM IN ORES BY CATHODE RAY POLAROGRAPHY. T. M. Florence. Apr. 1959. 14p.

A method is presented for the determination of uranium in ores by cathode ray polarography in which the uranium is separated by a simple and rapid mercury-cathode electrolysis and then determined polarographically in a base electrolyte in which vanadium, titanium, and tungsten do not interfere. Application of the method to the analysis of ten standard ores is shown. (auth)

## 3505

AERE-AM-52

United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Chatham Outstation, Kent, England.

THE DETERMINATION OF MANGANESE IN BERYLLIUM COMPOUNDS (FLUORIDE, HYDROXIDE AND AMMONIUM FLUORBERYLLATE). J. Walkden. Aug. 1959. 6p. BIS.

Solutions of the samples are fumed with sulfuric acid to remove fluoride and residues are dissolved in water. After adding silver nitrate and nitric acid the manganese is oxidized to permanganate by potassium periodate and is determined spectrophotometrically. The method is suitable for the determination of 5 to 100 ppm of manganese in beryllium fluoride and up to 50 ppm in ammonium fluorberyllate and beryllium hydroxide. Except at lower levels the error should not exceed  $\pm 5\%$ . (auth)

## 3506

AERE-AM-58

United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Chatham Outstation, Kent, England.

THE DETERMINATION OF TIN IN ZIRCALOY 2.

J. Walkden. Aug. 1959. 6p. BIS.

The sample is dissolved in sulfuric acid in the presence of ammonium sulfate. Some sulfur is liberated which is oxidized by nitric acid. The solution is fumed to remove excess nitric and sulfuric acids and the tin is reduced by aluminum and hydrochloric acid. The stannous chloride formed is titrated with iodine. The method is intended for use as a rapid check on the tin content of Zircaloy-2 and is suitable for the determination of amounts not exceeding 2% of tin. (J.E.D.)

## 3507

GAT-T-664

Goodyear Atomic Corp., Portsmouth, Ohio.

PRECISION MASS SPECTROMETRIC DETERMINATIONS OF URANIUM ISOTOPIC COMPOSITION. G. F. Kauffman and C. D. Tabor. May 21, 1959. 16p. Contract AT(33-2)-1. OTS.

Presented at the American Society for Testing Materials, Committee E-14, Meeting on Mass Spectrometry, Los Angeles, Calif., May 21, 1959.

Mass spectrometers are subject to a variable phenomenon called "memory" which amounts to 1 to 20% in the analysis of  $\text{UF}_6$ . A procedure using an interpolative method of standardization reduces the effect of memory to a negligible amount while at the same time compensating for or eliminating other sources of error. The use of a mass spectrometer for rapid and accurate determination of uranium isotopic abundance is described. (J.E.D.)

## 3508

IDO-14495

Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.

QUANTITATIVE GAMMA-RAY SPECTROMETRIC ANALYSIS OF NUCLIDE MIXTURES, CONSECUTIVE STANDARD SOURCES NULLIFICATION. D. G. Olson. Oct. 7, 1959. 41p. Contract AT(10-1)-205. OTS.

Conventional methods for analyzing fission product mixtures are lengthy and difficult. Gamma scintillation spectrometry shortens the analysis time and gives a visible



picture of what is being counted. However, for complex spectra, the graphical representation and interpretation of data require tedious plotting and data reduction time. In the proposed method a sample of mixed fission products is scanned by a 256-channel gamma spectrometer. Instrumental analysis of this spectrum is made, using complement, nuclide subtraction technique. Specific activities are determined for each nuclide using standard sources. The time required to make an analysis where four isotopes are present would be about 30 min. Statistical evaluation of the method has been made for cerium<sup>144</sup>, ruthenium<sup>106</sup>, cesium<sup>137</sup>, and niobium<sup>95</sup> in the experimental work. Since standard sources are required for the analysis this method is limited to reasonably long half-lived fission products. A similar method for other nuclides was published in *Analytical Chemistry* at the time this paper was being written. (auth)

### 3509 PGR-25(S)

United Kingdom Atomic Energy Authority. Production Group. Chemical Services Dept., Springfields, Lancs., England.

ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF MOLYBDENUM AND TUNGSTEN IN ZIRCONIUM METAL. Aug. 27, 1959. 7p. BIS.

Molybdenum and tungsten are determined absorptiometrically as the dithiol complexes, after extraction from an aqueous solution of the metal at controlled acidity. The analysis is applicable to samples of zirconium metal and sponge. (auth)

### 3510 WAPD-CTA(GLA)-543

Westinghouse Electric Corp. Bettis Plant, Pittsburgh. THE DETERMINATION OF NIOBIUM IN URANIUM NIOBIUM ALLOYS. G. W. Goward, T. M. Reinhold, and V. R. Wiederkehr. Feb. 28, 1958. Decl. Nov. 12, 1959. 4p. OTS.

The niobium-uranium alloy is dissolved in hydrofluoric nitric acids and the fluoride removed by fuming sulfuric acid. The niobium is hydrolyzed in an acid-sulfur dioxide medium and converted to niobic oxide by ignition at 900°C. The method covers the determination of niobium in niobium-uranium alloys having a niobium content of 8 to 12%. Metals which hydrolyze readily in dilute acid solutions interfere with the determination. (auth)

### 3511 Y-1276

Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn. DETERMINATION OF METALLIC IMPURITIES IN URANYL NITRATE SOLUTIONS BY X-RAY FLUORESCENCE. Richard E. Sladky. March 2, 1959. 25p. Contract W-7405-eng-26. OTS.

An x-ray fluorescence spectrometer was used to measure the concentration of iron in uranyl nitrate solutions. An estimate of the uranium concentration was obtained simultaneously. The sensitivity of the fluorescence method for eleven other elements was obtained. (auth)

### 3512 CEA-tr-R-521

MÉTHODES FRACTIONNÉES DE DOSAGE DE L'HYDROGÈNE DANS L'ANCIER. (Fractional Methods for Determination of Hydrogen in Steel). B. A. Shmelev (Chmelev). Translated into French by I. Melnick from *Metody Khim. Analiza Mineral.* Syr'ya 3, 263-9(1957). 16p.

In the release of hydrogen from steel under vacuum, four hydrogen fractions are obtained. The first occurs at room temperature to 200°C, the second at 600 to 650°C for alpha iron and at 1000 to 1100°C for gamma iron, the third during the fusion of the metal, and the fourth at 1500 to 1600°C. Various apparatus used to study the release of hydrogen at room temperature and during heating are sketched. The

kinetics of the hydrogen release are tabulated for different steels. The process for the release of the second fraction is studied in detail. Experiments showed that the hydrogen remaining in the crystal lattice after heating under vacuum is essentially molecular hydrogen held in the metal pores. (J.S.R.)

### 3513

RECENT DEVELOPMENTS AND CURRENT PROBLEMS IN INORGANIC ANALYTICAL CHEMISTRY. C. J. Rodden (New Brunswick Lab., AEC, N. J.). *Anal. Chem.* 31, 1940-5(1959) Dec.

The analysis of nuclear materials is divided into major and minor constituents. Under major constituents the analysis of nuclear materials used as fuels are uranium, thorium, plutonium, and alloys of these elements with other metals. The problems involved in the chemical analysis of these materials are considered as well as those involved in the determination of the isotopic composition of uranium. The determination of minor impurities in fuels as well as in moderators is considered under two categories. The most important is that group of elements which is undesirable because of neutron absorption. The other group is elements which are undesirable because of the effect on the metallurgy of the nuclear fuel or the moderator. (auth)

### 3514

NEUTRON ACTIVATION ANALYSIS OF SILICON CARBIDE. Lester F. Lowe, Harriet D. Thompson, and J. Paul Call (Air Force Cambridge Research Center, Mass.). *Anal. Chem.* 31, 1951-3(1959) Dec.

A method was developed for the analysis of high purity silicon carbide by neutron activation. After irradiation with thermal neutrons, the silicon carbide is decomposed with chlorine and oxygen at 1250°C. The induced activities are collected and analyzed to give the impurity levels. (auth)

### 3515

INTERACTION OF BETA PARTICLES WITH MATTER. ANALYSIS OF HYDROCARBONS BY BETA-RAY BACKSCATTERING. Peter R. Gray, Donald H. Clearey, and William H. Beamer (Dow Chemical Co., Midland, Mich.). *Anal. Chem.* 31, 2065-8(1959) Dec.

The determination of carbon-hydrogen ratios of hydrocarbons by  $\beta$ -ray backscattering is nondestructive, rapid, simple, and accurate. Mass density has a small effect on the  $\beta$ -ray backscatter intensity and the sample density must be known to 0.01 gram per cc. The standard deviation in the analysis of 13 hydrocarbons by  $\beta$ -ray backscattering is less than 0.03%. Mixtures of liquid hydrocarbons and solutions of solid hydrocarbons in hydrocarbon solvents are likewise analyzed to the same precision. (auth)

### 3516

A SIMPLE DETERMINATION OF URANIUM IN GRAPHITE. Raymond N. Rogers (Los Alamos Scientific Lab., N. Mex.). *Anal. Chem.* 31, 2071-2(1959) Dec.

A method is presented for the decomposition of uranium-loaded graphite reactor fuel elements and the determination of the degree of loading. The sample is decomposed by liquid combustion using sulfuric and perchloric acids. The uranium is determined by direct colorimetry of the resulting solution. Major advantages of the method are simplicity and low cost. (auth)

### 3517

LIQUID SCINTILLATION-COUNTING FOR [<sup>14</sup>C] STEROIDS. S. R. Stich (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *Biochem. J.* 73, 287-92(1959) Oct.

The assay of  $C^{14}$ -labeled steroids with the Ekco type N 612 liquid scintillation counter is described. The effects of scintillator volumes and concentration on the efficiency of the method are given. Self-quenching by 25 different steroids has been examined. None of the steroids, at the levels tested, exerted strong quenching effects, although slight quenching was apparent with some, in particular with equilenin and oestrone. The effect of impurities in the scintillator on the efficiency of the method has been investigated. Some additional variables which affect the reproducibility are discussed. (auth)

### 3510

THE DETERMINATION OF CHLORINE, BROMINE AND IODINE IN BIOLOGICAL MATERIAL BY ACTIVATION ANALYSIS. H. J. M. Bowen (Wantage Radiation Lab., Berks, Eng.). *Biochem. J.* **73**, 381-4(1959) Nov.

Methods are described for the determination of chlorine, bromine, and iodine in biological material by neutron-activation analysis. The ultimate limits of detection of the method are approximately  $10^{-8}$  g for chlorine,  $10^{-6}$  g for bromine, and  $10^{-10}$  g for iodine. The three halogens have been determined in seeds of the tomato (*Lycopersicon esculentum*) and in the nutrient solution on which the plant subsisted. Both bromine and iodine are concentrated relative to chlorine in the seeds, suggesting a physiological need for these elements. The mean values for the three halogens in whole human blood were found to be 2730  $\mu\text{g/g}$  (Cl; 7 patients), 2.75  $\mu\text{g/g}$  (Br; 7 patients) and 0.0419  $\mu\text{g/g}$  (I; 3 patients). The method is particularly recommended for the determination of bromine, since it is more sensitive and less subject to interference by other halogens than are other current methods. (auth)

### 3519

COMPLEXOMETRIC TITRATION OF RARE EARTH ELEMENTS. DISSOLUTION OF THE RARE EARTH OXALATE WITH ETHYLENEDIAMINETETRAACETIC ACID AND BACK TITRATION WITH MAGNESIUM SULFATE. Seizo Misumi and Tomitsugu Taketatsu (Kyushu Univ., Fukuoka). *Bull. Chem. Soc. Japan* **32**, 873-6(1959) Aug.

The processes for dissolution of the oxalate and complexometry to determine the small amounts of rare earth rapidly and accurately, were studied. Crystalline rare earth oxalate was precipitated and filtered. The precipitate was dissolved completely with EDTA in alkaline solution and the excess of EDTA in solution was back titrated with standard magnesium sulfate solution. By this procedure, rare earths in the range of a content about 1 to 5 mg, could be determined rapidly with a good accuracy. (auth)

### 3520

POTENTIOMETRIC DETERMINATION OF SMALL AMOUNTS OF HEXAVALENT URANIUM IN URANIUM DIOXIDE. Jerzy Minczewski, Roza Przytycka, and Lucja Kohman. *Chem. Anal. (Warsaw)* **3**, No. 1, 27-32(1958). (Translated from *Referat. Zhur. Khim.* No. 3, 1959, Abstract No. 7994).

For determination of small amounts of U(6+) in  $\text{UO}_2$  use is made of potentiometric titration with a solution of  $\text{Ti}_2(\text{SO}_4)_3$ . To 4 to 5 g  $\text{UO}_2$  in a Pt-dish are added 10 ml concentrated HF, 30 ml water, and the mixture is heated until a green precipitate ( $\text{UF}_4$ ) is formed containing no black particles. Thereafter the contents of the dish are diluted with water to 100 ml, 10 ml of the resulting solution are transferred to the potentiometric titration cell (with Pt- and  $\text{Hg}_2\text{Cl}_2$ -electrodes), 10 ml water and 3 g Rochelle salt are added and the temperature is raised to 70°. The titration is carried out with approximately 0.05 N solution of  $\text{Ti}_2(\text{SO}_4)_3$  in 4 N  $\text{H}_2\text{SO}_4$ .  $\text{CO}_2$  is added to remove  $\text{O}_2$  and to

stir the solution. The results so obtained show good reproducibility but are characterized by a positive error. Use of  $\text{H}_2\text{SO}_4$  for dissolving the sample results in analysis data which are much too high, but addition of the acid to the prepared solutions does not affect accuracy of the results.

### 3521

DETERMINATION OF HUMIDITY BY THE NEUTRON METHOD. Jiri Sloupenski and Miroslav Vorisek. *In-zinierski Stavby* **6**, 246-51(1958). (Translated from *Referat. Zhur. Khim.* No. 3, 1959, Abstract No. 8086).

A neutron sonde (NS), for determination of the moisture content of different materials, is described. Operation of the instrument is based on strong deceleration of fast neutrons on their passage through a medium containing hydrogen, as a result of which the number of slow neutrons that are formed is linearly correlated with the number of hydrogen atoms contained in the sample under study per unit of path of the neutrons.

### 3522

THE SPECTROGRAPHIC DETERMINATION OF TANTALUM AND NIOBIUM IN 18/8 STAINLESS STEELS. M. Neuilly. *Mem. sci. rev. mët.* **56**, 484-90(1959) Oct. (In French)

Spectrographic determinations of tantalum and niobium in 18/8 stainless steels are made after chemical separations by standard techniques. A Feussner spark source and a medium dispersion spectrograph are used for the spectrographic determination. The samples are compared with synthetic standards. The typical deviation calculated for concentrations between 0.03 and 0.25% was  $\pm 0.01\%$ . (tr-auth)

### 3523

URANIUM ANALYSIS BY GAMMA ABSORPTIOMETRY. R. E. Connally (General Electric Co., Richland, Wash.). *Nucleonics* **17**, No. 12, 98-102(1959) Dec.

A gamma absorptiometer employing a 10-mg  $\text{Am}^{241}$  source was developed for analyzing uranium solutions. The standard deviation for a single determination is less than 0.15% over the range 25 to 100 mg per l U. The system must be standardized twice a day to compensate for photomultiplier gain drift. The scintillation detecting system employs a NaI (Tl) crystal 2.0 cm in diameter by 0.5 mm thick. Light-element interference is low, however, fission product interference can be severe. (C.J.G.)

### 3524

TUNGSTEN-ARC WELDING OF TANTALUM IS FOUND TO BE THE MOST VERSATILE WELDING METHOD FOR JOINING THIS MATERIAL: BUT GREATER PREPARATION IS REQUIRED TO PROVIDE GOOD PROTECTION AND QUICK CHILLING. L. R. Haslip and B. S. Payne (Pfaudler Permutit, Inc., Rochester, N. Y.). *Welding J. (N. Y.)* **38**, 1165-74(1959) Dec.

The mechanical and welding properties of tantalum are given and welding processes are reviewed. Various types of shielding, machine welding equipment, and closed chambers for welding in an inert gas are compared. A variety of operating conditions under which tantalum can be welded is discussed. (C.J.G.)

### 3525

USE OF O-CRESOTIC ACID AS A REAGENT FOR THE ESTIMATION OF THORIUM AND ZIRCONIUM. T. N. Srivastava, S. P. Agarwal, and R. C. Aggarwal (Lucknow Univ., India). *Z. anal. Chem.* **169**, 254-7(1959).

Thorium and zirconium are precipitated quantitatively by o-cresotic acid at pH 3.7 and above. The precipitate in both cases can be ignited and weighed as the oxide. In



the case of thorium, the precipitate can also be weighed directly as  $\text{ThC}_2\text{H}_{14}\text{O}_8$  after drying at 105 to 110°C. This procedure is not possible in the case of zirconium as the precipitate is a basic salt of variable composition. (auth)

### 3525

RESEARCH FOR THE REALIZATION OF A METHOD OF DATING WITH RADIOCARBON. C. Ballarío and M. Benaventano (Istituto Nazionale di Fisica Nucleare, Rome); and C. Cortesi and F. Magistrelli (Università, Rome). p.32-5 of "Atti del 1° Convegno di Geologia Nucleare Tenuto in Roma il 4 Aprile 1955. (Acta of the 1st Congress of Nuclear Geology held in Rome, April 4, 1955)." Rome, Comitato Nazionale per le Ricerche Nucleari, 1955. 62p.

The nature and importance of radiocarbon dating are discussed. (T.R.H.)

### 3527

SONDERAUSSCHUSS RADIOAKTIVITÄT. RADIOCHEMISCHE METHODEN ZUR BESTIMMUNG VON RADIONUKLIDEN. (ARBEITSANLEITUNGEN). STRONTIUM 89 UND 90. (Special Committee on Radioactivity. Radiochemical methods for the Determination of Radionuclides. (Working Guide). Strontium 89 and 90). G. Herrmann and G. Erdelen, eds. and comps. No. 10 of "Schriftenreihe des Bundesministers für Atomkernenergie und Wasserwirtschaft. Strahlenschutz." Brunswick, Ger., Gersbach & Sohn Verlag GmbH, 1959. 77p. DM 4.

The general problem of the measurement of radioisotopes is discussed with a consideration of the measurement apparatus, counter characteristics, zero effect and anticoincidence counting, control of a counter apparatus, determination of absolute activity, preparation of samples, radiochemical techniques, identification of activities, and accuracy of the measurements. The methods used for the determination of  $\text{Sr}^{89}$  and  $\text{Sr}^{90}$  are reviewed. Laboratory procedures are given for the separation of radiostrontium from tap water, the soil, plants, milk and milk products, bones, and urine. Procedures are also given for the determination of radiostrontium in the atmosphere and for the specific determination of  $\text{Sr}^{89}$  and  $\text{Sr}^{90}$ . The method used for the determination of the calibration factor of  $\text{Y}^{90}$  is described. (J.S.R.)

## Radiation Chemistry

### 3528 ER-10317

Martin Co., Baltimore.

RADIATION CHEMISTRY OF TEFLON. R. Hornbeck. June 1958. 30p.

The effects of ionizing radiation on polytetrafluoroethylene (Teflon) have been studied with respect to the kinetics of gas evolution and chain scission. Irradiations were performed *in vacuo* with a  $\text{Co}^{60}$  gamma source at a dose rate of  $3.3 \times 10^7$  ergs/gmC per hour. Thin films and powder were irradiated and heated to determine the absolute rate of gas formation. Up to a limit of  $10^{10}$  ergs/gmC, the average rate of production of single carbon atom gases was one microliter (STP) per gram of polymer-hour of irradiation. This corresponds to a G-value of 0.12 molecules per 100 electron volts of deposited energy. The G-values found for  $\text{C}_2$ ,  $\text{C}_3$ , and  $\text{C}_4$  gases were 0.03, 0.002, and 0.004, respectively. The irradiated polymer was extracted with a partially fluorinated solvent and the percent soluble plotted as a function of total dose. A log-log plot gave a straight line relationship with a slope of 4/3. Generally, the radiation chemistry of fluorocarbons can be related to the changes observed in the physical and mechanical properties of the

irradiated polymer. The rapid degradation of polytetrafluoroethylene by ionizing radiation can be attributed chiefly to the prevalence of main chain scission by liberated fluorine atoms and the production of entrapped fluorocarbon gases. Possibilities for improving the radiation resistance of fluorocarbon polymers include developing styrene type structures and incorporating fluorine atom scavengers in the molecule, e.g., hydrogen or trifluoromethyl radicals. (auth)

### 3529 NYO-2717

TRG, Inc., Syosset, N. Y.

SYNTHESIS OF SEMI-CONDUCTOR MATERIALS BY RADIATION INDUCED REACTIONS. Quarterly Status Report No. 2 [for] August 1, 1959–November 1, 1959. 11p. Contract AT(30-1)-2392. (TRG-132-QTR-2). OTS.

Work is reported on the preparation of monosilane, and the filling of glass containers at various pressures with this material. Irradiation of the silane samples with a  $\text{Co}^{60}$  source is reported. Pressure measurements were made on irradiated samples to determine whether reaction had taken place and to what extent it may have proceeded. Experiments to study the kinetics of the thermal decomposition of silane were designed and set up. (W.L.H.)

### 3530

DECOMPOSITION OF SOLID AMMONIUM NITRATE BY  $\gamma$ -RAY. Toshiaki Shirai and Masaru Nishikawa (Univ. of Tokyo). *Bull. Chem. Soc. Japan* 32, 879(1959) Aug.

The decomposition of solid  $\text{NH}_4\text{NO}_3$  by  $\gamma$  rays was performed. The effect of salt addition on the rate of decomposition was studied. The decomposition was found to accelerate upon the addition of metal ions. (C.J.G.)

### 3531

DIRECT UTILIZATION OF FISSION ENERGY FOR RADIATION PROCESSING. Ward S. Diethorn, Paul Schall, Jr., and G. D. Calkins (Battelle Memorial Inst., Columbus, Ohio). *Chem. Eng. Progr.* 55, Symposium Ser. No. 22, 119-25(1959).

The utilization of fission recoils in a reactor as a radiation processing source is discussed. Geometric considerations indicate that efficient utilization of the fission recoils requires very small fuel-element dimensions and circulation of the chemical reactants through the reactor core. The only reactor coolant would probably be the chemical reactants. The yield of a chemical product produced in this type of reactor can be calculated from a simple equation in terms of G value, reactor power, reactor temperature, and specific heats of the chemical reactants. For many radiation-induced reactions, high product yields will be realized only at high operating temperatures and after extensive recycling. (C.J.G.)

### 3532

THE EFFECTS OF GAMMA RADIATION ON SEVERAL POLYSULFONE REACTIONS. PART I. PHYSICAL PROPERTIES OF THE COPOLYMERS. PART II. KINETICS OF THE REACTIONS. Bruce G. Bray, Joseph J. Martin, and Leigh C. Anderson (Univ. of Michigan, Ann Arbor). *Chem. Eng. Progr.* 55, Symposium Ser. No. 22, 173-99(1959).

Ethylene, propylene, butene-1, butene-2 (*cis* and *trans*), isobutylene, n-hexene-1, n-decene-1, n-dodecene-1, and cyclopropane, were reacted with sulfur dioxide under the influence of gamma radiation to produce copolymeric materials. The recovered products were analyzed and the following properties studied: melting or softening range, density, intrinsic viscosity, tensile strength, elongation, sulfur content, solubility, and decomposition point. The ef-

fect of radiation on the kinetics of the reactions was studied. (C.J.G.)

### 3533

NEW PROOFS OF THE PRECIPITATION OF METALLIC LITHIUM IN LITHIUM SALTS IRRADIATED BY THERMAL NEUTRONS. Marianne Lambert, Pierre Berge, Charles Mazières, and André Guinier (Université, Paris). *Compt. rend.* **249**, 2054-6(1959) Nov. 16. (In French)

It has been shown by x-ray diffraction that for sufficiently high neutron irradiations precipitation of metallic lithium is formed at the interior of lithium fluoride crystals. Differential thermal analysis confirms these results. The neutron decomposition of lithium hydride was also studied by x-ray diffraction, differential thermal analysis, and chemical methods. (J.S.R.)

### 3534

ELECTRON PARAMAGNETIC RESONANCE SPECTRA AND THE ACCUMULATION KINETICS OF RADICAL PRODUCTS FORMED WHEN FROZEN AQUEOUS SOLUTIONS OF SODIUM NITRATE ARE BOMBARDED BY FAST ELECTRONS. Yu. N. Molin, V. A. Sharpatyi, and N. J. Buben (Karpov Scientific Research Inst. of Physics and Chemistry, USSR). *Doklady Akad. Nauk S.S.S.R.* **128**, 1224-7(1959) Oct. 21. (In Russian)

An attempt was made to determine the radical products and mechanism of radiolytic nitrate transformation in frozen solutions. (R.V.J.)

### 3535

ELECTRON PARAMAGNETIC RESONANCE SPECTRA FOR SOME CATALYSTS OF CATALYST-HYDROCARBON SYSTEMS AND THE ACTION OF  $\gamma$ -RAYS ON THEM. Yu. A. Kolbanovskii, I. M. Kustanovich, L. S. Polak, and A. S. Shcherbakova (Inst. of Chemical Synthesis of Petroleum, Academy of Sciences, USSR). *Doklady Akad. Nauk S.S.S.R.* **129**, 145-8(1959) Nov. 1. (In Russian)

Electron paramagnetic resonance spectra for catalysts and catalyzed hydrocarbon systems were used in determining catalytic chemisorption processes. The data were obtained with representative oxide catalysts used in cracking, dehydrogenation, dehydrocyclization, and desulfurization in representative basic hydrocarbons. Data are presented which indicate action of  $\gamma$  rays the radiolysis of hydrocarbons and heterogenic systems. (R.V.J.)

### 3536

THE CHAIN ALKYLATION OF ACETYLENE WITH PROPANE INDUCED BY NUCLEAR RADIATION. W. Bartok and P. J. Lucchesi (Esso Research and Engineering Co., [Linden, N. J.]). *J. Am. Chem. Soc.* **81**, 5918-21(1959) Nov. 20.

The chain alkylation of acetylene with propane to yield predominantly 3-methyl-1-butene is reported. This reaction is initiated by mixed pile nuclear radiation at 10 to 15 atm pressure and 250 to 400°. At these conditions, it has a chain length which varies between 7 and 12 and increases inversely with the square root of intensity. The rate is roughly first order in acetylene. At the same conditions, no alkylation is observed thermally and indeed the thermal alkylation cannot be studied because at temperatures required for its initiation, acetylene side reactions predominate. The reaction is discussed from the viewpoint of a free radical chain mechanism. From the data and the assumed mechanism, a value of 4.5 kcal can be estimated as the activation energy for the addition of sec-propyl radicals to acetylene. (auth)

### 3537

HIGH ENERGY ELECTRON IRRADIATION OF n-HEXANE.

Jean H. Futrell (Humble Oil and Refining Co., [Baytown, Tex.]). *J. Am. Chem. Soc.* **81**, 5921-4(1959) Nov. 20.

A study of the radiation chemistry of normal hexane in gas and liquid phase as the pure compound and in admixture with radical scavengers in the gas phase is reported. The radiolysis products which were determined are hydrogen, propane, ethylene, n-butane, ethane, methane, propene, acetylene, hexane isomers, isobutane, butene, isopentane, and n-pentane, listed in order of decreasing "G"-values. The nature and yields of these products and the effect of radical scavengers are rationalized with satisfactory precision from the assumption that initial ionization processes, followed by very fast ion-molecule reactions of the hydride ion transfer type, dominate the reaction process. It is therefore tentatively suggested that such a partial mechanism has considerable validity for normal hexane and related compounds. (auth)

### 3538

WATER SUBEXCITATION ELECTRONS IN AQUEOUS FORMIC ACID RADIOLYSIS. Edwin J. Hart (Argonne National Lab., Lemont, Ill.). *J. Am. Chem. Soc.* **81**, 6085-6(1959) Nov. 20.

In view of carbon monoxide formation by light in formic acid irradiated by gamma rays, direct dissociation of excited formic acid by water subexcitation electrons is postulated. (C.J.G.)

### 3539

COMPARISON OF HIGH-ENERGY AND ULTRAVIOLET-RADIATION INDUCED LUMINESCENCE IN LIQUID SYSTEMS. Sanford Lipsky and Milton Burton (Univ. of Notre Dame, Ind.). *J. Chem. Phys.* **31**, 1221-6(1959) Nov.

Luminescence induced by  $\text{Co}^{60}$ -gamma excitation of some organic solvent-solute pairs has been compared with 2537 Å excitation as to dependence of intensity on solute concentration and on concentration of an added quencher. The solutions studied were 1,6-diphenylhexatriene in benzene, p-terphenyl in benzene, and p-terphenyl in toluene. The quencher was bromobenzene. The energy-transfer parameter Q of the Kallmann-Furst theory and the quenching constant were obtained for each of the systems. Within an estimated experimental error of about 5%, Q was unaffected by change in source of excitation. The efficiency of quenching was found to be greater for  $\text{Co}^{60}$ -gamma than for u-v excitation for the two systems involving p-terphenyl. With diphenylhexatriene as solute, however, the quenching constant was unchanged. These results argue against a mechanism of energy exchange involving charge transfer. The high rates of transfer and quenching are consistent with a picture of the solvent involving the existence of small ordered regions within which exciton transfer can occur so that the entire region is viable to attack by a foreign molecule with resultant quenching or energy transfer. (auth)

### 3540

PECULIARITIES OF OZONE FORMATION IN ELECTRON IRRADIATION OF NITROGEN-OXYGEN MIXTURES. J. E. Douglas, L. C. Bratt, and E. M. Kinderman (Stanford Research Inst., Menlo Park, Calif.). *J. Chem. Phys.* **31**, 1416(1959) Nov.

The effect of container cell materials such as aluminum and pyrex on the ozone formation in an oxygen-nitrogen mixture irradiated with 1-Mev electrons was studied. (J.E.D.)

### 3541

SOME OBSERVATIONS ON BIPHENYL RADIOLYSIS. K. Lynn Hall and Fred A. Elder (California Research



Corp., Richmond). *J. Chem. Phys.* **31**, 1420-1(1959) Nov.

Yields of low-molecular-weight products from the gamma radiolysis of biphenyl are reported. Some low energy electron impact experiments are described which bear on the radiolysis mechanism. (J.E.D.)

### 3542

THE EFFECT OF SIMULTANEOUS CROSSLINKING AND DEGRADATION ON THE INTRINSIC VISCOSITY OF A POLYMER. R. W. Kilb (General Electrical Research Lab., Schenectady, N. Y.). *J. Phys. Chem.* **63**, 1838-43(1959) Nov.

The change in intrinsic viscosity  $[\eta]$  is studied for a process during which a polymer is simultaneously degraded and crosslinked. An example of such a process is irradiation of polymers. It is possible to determine the relative amount of degradation and crosslinking by following the change of  $[\eta]$  during the process. Qualitative agreement of theory with experiment is good. Quantitatively the method is limited to the range unity to ten for the ratio of degradations to crosslinks; outside these limits the shape of the  $[\eta]$  curve is insensitive to this ratio. It is found that the best sensitivity is obtained when  $[\eta]$  is determined in  $\Theta$  solvents. By following the change in osmotic and light scattering molecular weight for silicone irradiated by an electron source, the ratio of degradations to crosslinks was found to be less than 0.5. (auth)

### 3543

CROSSLINKING OF POLYMERS IN SOLUTION UNDER THE INFLUENCE OF  $\gamma$ -RADIATION. Arnim Henglein (Mellon Inst., Pittsburgh). *J. Phys. Chem.* **63**, 1852-8 (1959) Nov.

Polyvinylpyrrolidone, polyvinyl acetate, and polystyrene simultaneously undergo intermolecular crosslinking and degradation of their main chains when irradiated in solution. Below a critical concentration which depends on the solvent no continuous network is built up since degradation is the predominant reaction in dilute solutions. Only a few solvents or mixtures of solvents in which this critical concentration is smaller than 10 g/100 cc have been found for each of these polymers. No relation exists between the radiation sensitivity of the solvent and the rate of crosslinking of dissolved polymers. However, crosslinking seems to be slightly favored in poor solvents. Observations on the gel dose show that this often increases with increasing polymer concentration in concentrated solutions. Radical scavengers inhibit crosslinking of these polymers and often are incorporated into the polymers. A mechanism is proposed in which the formation of macroradicals and low molecular weight radicals from the solvent by direct action of radiation are the primary steps. Crosslinks are formed by combination of macroradicals. The solvent radicals sensitize or retard crosslinking by attacking the polymer to form additional macroradicals or by deactivating macroradicals, respectively. The increase in gel dose in concentrated solutions is attributed to the decrease in the rate constant for the combination of the free macroradicals in viscous solutions as is well known from the autoacceleration observed in the bulk polymerization of a number of vinyl monomers. (auth)

### 3544

EFFECTS OF IONIZING RADIATIONS ON SYNTHETIC POLYMER SOLUTIONS. Shintaro Sugai (Hokkaido Univ., Sapporo). *J. Phys. Soc. Japan* **14**, 1573-82(1959) Nov.

Aqueous solutions, containing dissolved oxygen, of sodium salt of carboxy-methyl cellulose and of polyacrylic acid were irradiated with  $\gamma$ -rays from  $\text{Co}^{60}$  or with 90 kv

x-rays. The degeneration of molecules in the solutions brought about under various conditions was studied by viscometric, ultracentrifugal, and electrical measurements. Ideal indirect kinetics of main chain fractures through activated water were recognized in all the cases, from highly concentrated solutions to fairly diluted ones. In the case of extremely diluted solutions free-radical recombination seems to make the reaction inefficient. Information as to the molecular extension and form in the solution was derived. Inclusion of salts and alcohols in the solution protects effectively the degeneration due to irradiation, which can be explained satisfactorily on the assumption of an "indirect effect." The molecular contraction and change of molecular form caused by the inclusion of salts were estimated. The irradiation effect on dilute solutions of non-electrolyte polymers was also investigated. Chain fracture efficiency was about the same as in polyelectrolyte molecules in the same concentration range. Here the rate of fracture seems to indicate again the "indirect effect." It is concluded that electrical charges on polyelectrolyte molecules, in a certain range, are not essential for degradation and their extension is not much different from that of non-electrolyte molecules. It was observed in the case of concentrated polyelectrolyte solutions containing oxygen that irradiation does not give rise to formation of gel, although micro-gel may be formed. (auth)

### 3545

THE KINETICS OF RADICAL REACTIONS IN  $\gamma$ -IRRADIATED POLYVINYL CHLORIDE. Kenzi Hukuda, Jiro Ishii, and Zenemon Miduno (Kyusyu Univ., Fukuoka, Japan). *J. Phys. Soc. Japan* **14**, 1643-4(1959) Nov.

The rates of production and extinction of radicals in  $\gamma$ -irradiated polyvinyl chloride were studied by means of electron spin magnetic resonances at 3 cm wavelength. The radical reaction constants  $\lambda$  and  $\lambda_2$  were estimated to be 18 and 4 kcal/mole, respectively. (C.J.G.)

### 3546

FORMATION OF GRAFT POLYMERS BY  $\gamma$ -IRRADIATION OF NATURAL RUBBER LATEX AND METHYL METHACRYLATE. E. G. Cockbain, T. D. Pendle, and D. T. Turner (British Producers' Research Assn., Welwyn Garden City, Herts, Eng.). *J. Polymer Sci.* **39**, 419-26 (1959) Sept.

Exposure of mixtures of natural rubber latex and methyl methacrylate to  $\gamma$ -radiation from a  $\text{Co}^{60}$  source results in polymerization of the methyl methacrylate to give a mixture of the homopolymer and grafted polymer. The ratio of grafted polymer to homopolymer and the molecular weight of the homopolymer are both considerably higher than in similar systems where polymerization was initiated by a redox catalyst. The ability of the irradiated lattices to form continuous films on drying is much greater than that of corresponding redox-polymerized systems. This difference is attributed primarily to the location of the polymerized methyl methacrylate throughout the individual latex particles, the polymerized methacrylate being more uniformly distributed in the case of the irradiated latex. Use of polymerization retarders which are soluble in methyl methacrylate swollen rubber supplies evidence that an increased proportion of the polymerized methacrylate is located in the surface regions of the latex particles. Conversely, a more uniform distribution of the polymer is obtained by the use of water-soluble retarders. The probable significance of these results in relation to emulsion copolymer systems is pointed out. (auth)

### 3547

THE APPLICATION OF PHOTOCHEMICAL PRINCIPLES

TO RADIATION CHEMISTRY. R. W. Hummel and R. L. Vale (Wantage Radiation Lab., Berks, Eng.). J. Polymer Sci. **39**, 538-9(1959) Sept.

The rate of monomer disappearance in a radiation-induced polymerization reaction is shown to be proportional to  $[M]^{1/2}$ . (C.J.G.)

### 3548

THE GAMMA RADIOLYSIS OF BUTYL CHLORIDES. Edward B. Dismukes and William S. Wilcox (Southern Research Inst., Birmingham, Ala.). Radiation Research **11**, 754-60(1959) Dec.

The  $\gamma$ -ray-induced decomposition of butyl chlorides produces appreciable yields of *n*-butane from the two straight-chain isomers, normal and secondary, and of isobutane from the two branched-chain compounds, iso and tertiary. At least 50% of the chlorine corresponding to these hydrocarbons appears as hydrogen chloride and dichlorobutanes. A substantial degree of isomerization of the normal and iso compounds occurs, probably to the secondary isomer in the former case and unmistakably to the tertiary isomer in the latter case. (auth)

### 3549

RADIATION-INDUCED DECOMPOSITION OF FERRI-PROTOPORPHYRIN IN AQUEOUS ALKALINE SOLUTION. L. S. Myers, Jr., Mary-Louise Rothschild, Marianne Kersten, and Laura Cosi (Univ. of California, Los Angeles). Radiation Research **11**, 761-75(1959) Dec.

The main path for the radiation-induced decomposition of ferriprotoporphyrin (FPP) in 0.1 N NaOH is by a series of consecutive bimolecular reactions which give pseudo-first-order kinetics. The first observed step appears to be an oxidation, possibly accompanied by polymerization, to a compound with an FPP-like spectrum (FPP') in which the resonating ring system of the porphyrin molecule remains intact. The second step involves destruction of the resonating porphyrin ring system, possibly by a series of reactions initiated by radiation, and possibly involving more than one colored compound. Subsequent steps produce further colorless degradation products which partially protect the unreacted FPP and FPP' and give rise to the apparent first-order kinetics and inverse dependence of the rate constants on concentration. The yields for the first and second reactions are 7.1 and 0.3, respectively. Other reactions than those considered above may be occurring. (auth)

### 3550

CHEMICAL EFFECTS OF RADIATIVE THERMAL NEUTRON CAPTURE. PART 5. POTASSIUM BROMIDE. A. G. Maddock and M. del Val Cob (University Chemical Labs., Cambridge, Eng.). Trans. Faraday Soc. **55**, 1709-13 (1959) Oct.

By the use of the bromine atom exchanging reagent CHBr:CHBr, it was shown that the specific activity of the atomic bromine in pile-irradiated potassium bromide is greater than that of the total bromine. This result suggests that the inactive radiolytic bromine atoms and the ejected radioactive atoms occupy different defect sites, the latter most likely finding interstitial positions. (auth)

### 3551

HYDROCARBON CONVERSION PROCESS. (to Esso Research and Engineering Co.). British Patent 823,426. Nov. 11, 1959.

A process is presented for desulfurizing, polymerizing, dehydrogenating, isomerizing, aromatizing, and cracking petroleum feedstock by combined  $\gamma$  and neutron irradiation in the presence of a catalyst. The preparation of  $SiO_2-Al_2O_3$ ,  $Al_2O_3$ , Pt on  $Al_2O_3$ ,  $B_2O_3$  on  $SiO_2-Al_2O_3$ ,  $B_2O_3$

on  $Al_2O_3$  for use as catalysts is described. By proper choice of catalyst and conditions the desired product is obtained. Preferred conditions are 650 to 1000°F for boiling range of petroleum feed, operating temperature 150 to 800°F, gamma flux of 1 to  $3 \times 10^5$  r/hr, neutron flux of  $10^{12}$  to  $10^{13}$ /cm<sup>2</sup>/sec with 20 to 50% fast neutrons, and average catalyst particle size of 1000  $\mu$ . Examples of the process are given. (T.R.H.)

## Radiochemistry

### 3552 GA-910

General Atomic Div., General Dynamics Corp., San Diego, Calif.

STUDIES OF THE SZILARD-CHALMERS PROCESSES. Final Report. Rodman A. Sharp and Roman A. Schmitt. Aug. 15, 1959. 43p. Contract AT(04-3)-167, Project Agreement No. 3. OTS.

The Szilard-Chalmers process is a method for producing radioisotopes whose specific activity is much higher than that obtained in a simple metal or salt target. A number of Szilard-Chalmers processes were investigated and simple and effective procedures devised for the following radioisotopes: 38-min  $Cl^{38}$ , 2.6-hr  $Mn^{56}$ , 12-hr  $Cu^{64}$ , 14-hr  $Zn^{68m}$ , 27-hr  $As^{76}$ , 36-hr  $Br^{82}$ , 4.6-hr  $Br^{80}$ , 27-hr  $Sn^{131}$ , and 25-min  $I^{128}$ . The target preparation, separation scheme, exposure level, and expected minimum yield and enrichment are given. The yields are generally independent of exposure up to at least 100 kw-hr ( $2 \times 10^{16}$  nvt) while enrichments increase with decreasing exposure. (W.L.H.)

### 3553

RADIATION SOURCE FABRICATION AND HANDLING. Eugene Lamb (Oak Ridge National Lab., Tenn.). Chem. Eng. Progr. **55**, Symposium Ser. No. 22, 77-81(1959).

Probable chemical compounds of the radiation sources, source forms, and source design are proposed. Examples of possible carrier designs and irradiator loading techniques are discussed. Factors to be considered in the successful design and operation of an irradiator are given. (C.J.G.)

### 3554

EXPERIMENTAL TECHNIQUES IN HEAVY ELEMENT-CHEMISTRY. A. G. Maddock. Énergie nucléaire **1**, 206-9(1959) Sept.-Oct. (In French)

The particular problems involved in heavy-element chemistry are pointed out: small quantities available, toxicity, and difficulty of separation. Classical techniques have been adapted, and new techniques such as ion exchange and paramagnetic resonance have been developed. The importance of pulse analyzers and scintillation spectrometers is discussed. (T.R.H.)

### 3555

PRODUCTION OF TRANSURANIC ELEMENTS IN WEIGHABLE QUANTITIES. André Chesné. Énergie nucléaire **1**, 210-16(1959) Sept.-Oct. (In French)

The factors involved in preparation of transuranic elements are reviewed: starting material, physical conditions, and the technological problems in chemical separation. (T.R.H.)

### 3556

RAPID DETERMINATION OF MIXED BETA-GAMMA RADIONUCLIDES IN URINE. A. L. Boni (E. I. du Pont de Nemours & Co., Alken, S. C.). Health Phys. **2**, 186-8 (1959) Oct.

A bio-assay procedure was developed which enables a



rapid estimation of the total amount of  $\beta$ - $\gamma$  emitting isotopes in a urine specimen. The  $\beta$ - $\gamma$  emitting radionuclides are coprecipitated from urine on an ammoniacal alkaline earth phosphate precipitate. The filtered precipitate is fired in a muffle furnace, dissolved, and directly plancheted. The planchet is both  $\beta$ - and  $\gamma$ -counted. The recoveries of strontium-89, strontium-yttrium-90, zirconium-niobium-95, cerium-praseodymium-144, iron-59, chromium-51, and zinc-65 are greater than 90%. Cobalt has a recovery of 85%. (auth)

**3557**

EMERGENCY MONITORING METHODS FOR THE DETERMINATION OF THE EFFECTIVE BONE-SEEKING FISSION PRODUCTS IN MILK. N. Irving Sax, Robert J. Sherer, and Robert T. Drew (New York State Dept. of Health, Albany). *Health Phys.* **2**, 216-17(1959) Oct.

A radiochemical-radiometric procedure is described for determining bone-seeking fission products in milk. The procedures permit completion of a few samples by a single technician in 6 to 8 hours. (C.J.G.)

**3558**

FABRICATION OF THICK HOMOGENEOUS  $\beta$  SOURCES. D. C. Lawrence (Atomics International, Canoga Park, Calif.). *Health Phys.* **2**, 217-18(1959) Oct.

A method of mixing known amounts of the required radioisotope in a water solution with known weights of a water hardening material, commercially called "wood putty," is described. This material was found to give solid, reproducible, homogeneous  $\beta$ -standards. (C.J.G.)

**3559**

THE CHEMISTRY AND APPLICATION OF TRITIUM LABELING. Charles Rosenblum (Merck Sharp and Dohme Research Labs., Rahway, N. J.). *Nucleonics* **17**, No. 12, 80-83(1959) Dec.

Tracer preparation by direct exposure to tritium gas is discussed. The use of paper chromatography to ensure purity of a labeled material for use as a tracer is illustrated with 17-hydroxycorticosterone. The addition of tritium to carbon-carbon double bonds is discussed. Double labeling with tritium and carbon-14 for assaying steroids in biological extracts is reviewed. The application of tritium in the determination of gibberellins in fermentation liquors and in plant tissues and for ascertaining the efficiency of processes on an operational scale are discussed. (C.J.G.)

## Raw Materials and Feed Materials

**3560** NP-8069

Eldorado Mining and Refining Ltd. Research and Development Div., Ottawa.  
RESEARCH AND DEVELOPMENT REPORT FOR OCTOBER 1959. 55p. (R-59-10).

New Process Development. Chlorination tests on a sample of Beaverlodge mill feed gave U volatilization of 59, 79, and 88% on -14 +28, -35 +48, and -65 +100 mesh size fractions, respectively. On a sample of Verna 744 refractory are, 52% -200 mesh, U volatilization was 64%. Pilot-scale cycloning tests were carried out on desanding of acid leach slurry preparatory to solvent extraction of U from the slurry. Amalgam reduction tests on synthetic Beaverlodge carbonate solution indicated that product grade is improved with increasing precipitation temperature and decreasing Na concentration in the amalgam. In electrolytic reduction tests further difficulties were encountered in handling precipitate which forms in the Hg cathode diaphragm cell. Process Development. The addition of sur-

face active agents in carbonate leaching appeared to yield slight improvement in U extraction. Jaguar 507 appeared to be nearly twice as effective as Separan 2610, on a weight basis, as a filter aid for carbonate leach pulp. Tests were resumed in a study of variables affecting the Beaverlodge caustic precipitation process. Nionel and 309 stainless steel were found to be satisfactory materials of construction for equipment for sodium chlorate-ferric iron leaching of metal plant scrap material. (For preceding period see NP-7950.) (W.L.H.)

**3561** RMO-4016

Columbia Univ., New York. Mineral Beneficiation Lab. RECOVERY OF URANIUM FROM CHATTANOOGA SHALE. COST ESTIMATION OF A SOLVENT EXTRACTION PLANT. Sept. 1959. 66p. Contract AT(49-1)-621. OTS.

Fixed bed ion exchange and amine complexant solvent extraction were studied as methods to recover U from Chattanooga shale leach solutions. The design and cost estimation of a solvent extraction plant for shale leach solutions is presented. (W.L.H.)

**3562** RMO-4017

Columbia Univ., New York. Mineral Beneficiation Lab. RECOVERY OF URANIUM FROM CHATTANOOGA SHALE. COST ESTIMATION OF AN ION EXCHANGE PLANT. Sept. 1959. 54p. Contract AT(49-1)-621. OTS.

Fixed bed ion exchange and amine solvent extraction were studied as methods to recover U from Chattanooga shale leach solutions. The design and cost estimation of an ion exchange plant for shale leach solutions is presented. (W.L.H.)

**3563**

ENGINEERING CONTINUOUS FILTRATION TO THE URANIUM ORE-PROCESSING FLOW SHEET. C. F. Cornell, R. C. Emmett, and D. A. Dahlstrom (Elmco Corp., Palatine, Ill.). *Chem. Eng. Progr.* **55**, Symposium Ser. No. 22, 139-57(1959).

A simplified flowsheet is presented for both the carbonate and sulfuric acid leach processes for uranium ore. Methods of testing, analysis, and correlation of resultant data for the prediction of full-scale results, special requirements, and final engineering of each continuous filter are given for all the five major filtration steps in the uranium mill. (C.J.G.)

## Separation Processes

**3564** AAEC/E-40

Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales.  
DEVELOPMENT OF A TEN STAGE MIXER SETTLER FOR U<sup>235</sup> SOLUTIONS. PART I. M. G. Baillie and R. C. Cairns. Nov. 1958. 24p.

The development of a ten-stage mixer settler is presented. The unit is based on extraction conditions expected for Dido reactor fuel elements. Qualitative experimental work is reported for a single stage mixer settler. A brief review of the criticality problem for processing uranium-235 enriched fuel is given and actual dimensions are specified for the case of Dido reactor elements. Proposed work with the ten-stage unit is given. (auth)

**3565** CF-59-10-101

Oak Ridge National Lab., Tenn.  
CHEMICAL TECHNOLOGY DIVISION, CHEMICAL DEVELOPMENT SECTION C MONTHLY PROGRESS REPORT, OCTOBER 1959. Nov. 11, 1959. 53p. OTS.

A stripping method for the amine extraction (Amex)

process, involving treatment of the U-loaded extract with  $(\text{NH}_4)_2\text{SO}_4$  solution while adjusting the pH to 3.5 to 4 with  $\text{NH}_4\text{OH}$ , was demonstrated in continuous equipment. The steady-state distribution losses of 1-nonyldecylamine, 1-undecylaurylamine, bis(1-heptyloctyl) amine, bis(1-nonyldecyl) amine, N-benzyl-1-nonyldecylamine, and N-benzyl-1-undecylaurylamine were all less than 5 ppm to typical ore leach liquor. A tentative process for recovery of strontium from Purex 1-WW solutions by di(2 ethylhexyl) phosphoric acid was demonstrated with synthetic solutions in a laboratory pulse column. Batch countercurrent laboratory studies of a promising and relatively radiation-stable U-Pu extraction reagent are reported. The amine extraction of Th was studied. (W.L.H.)

#### 3566 HW-61875(Del.)

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

HANFORD NEPTUNIUM OXALATE-OXIDE PROCESS EXPERIENCE. C. W. Pollock and R. A. Schneider. July 1, 1959. Decl. with deletions Oct. 30, 1959. 11p. Contract AT(45-1)-1350. OTS.

The over-all recovery process consisted of isolation from Purex plant solutions by solvent extraction, to yield an impure neptunium nitrate solution contaminated principally with U, Pu, and fission products; purification by anion exchange; precipitation of neptunium(IV) oxalate; and calcination of the oxalate to yield  $\text{NpO}_2$ . The oxalate precipitation process investigations and results are described. (W.L.H.)

#### 3567 HW-61848

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

EUROCHEMIC QUESTIONS—PRELIMINARY REPORT. R. G. Geier. Aug. 24, 1959. Decl. Oct. 7, 1959. 30p. Contract AT(45-1)-1350. OTS.

Several questions asked by Eurochemic personnel on the operation of the Purex Plant are presented. (W.L.H.)

#### 3568 WCAP-6032

Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.

NUCLEAR MATERIALS CONTROL SYSTEM (NMCS). PHASE II. ANALYTICAL PROCEDURES AND FACILITIES FOR A NUCLEAR MATERIALS CONTROL SYSTEM. C. C. Thomas, Jr. Dec. 1, 1959. 49p. Contract AT(30-1)-2176, Task I. OTS.

Analytical procedures and facilities suitable for use in a Nuclear Materials Control System (NMCS) are specified. Techniques, precisions, and accuracies are considered for the analysis of various process samples for uranium, plutonium, free acid, specific gravity, and other data. The handling and storage of analytical samples is also discussed, and specific recommendations are given. (auth)

#### 3569 CEA-tr-A-343

OBTENTION EN CONTINU DE COMPOSES PURS DE CERIUM AU MOYEN D'UNE COLONNE D'EXTRACTION A CONTRE-COURANT. (Continuous Preparation of Pure Cerium Compounds by Use of a Counter-Current Extraction Column). R. Bock and K. H. Meyer. Translated into French by B. Moreau from *Chem. Ingr. Tech.* 3, 141-2 (1953). 10p.

A counter-current extraction column is described for the extraction of  $\text{Ce}^{4+}$  from a nitric solution of the rare earths with ethyl ether. The extraction column consists of a glass tube 150 cm long and 4 cm in diameter. Raschig rings are placed in the tube and rest on a glass spiral. The two ends of the column are stopped with plugs which permit the inlet and outlet of the solutions. The solvent inlet and the evacu-

ation tube for the aqueous phase are on the bottom of the tube. The ether inlet is divided into three branches. Eighty five per cent of the cerium in the nitric solution is extracted and the  $\text{CeO}_2$  prepared is 99.5% pure. (J.S.R.)

#### 3570

SOLVENT EXTRACTION OF METAL CHELATES. I. APPLICATION OF A TITRATION PROCEDURE TO THE STUDY OF THE EXTRACTION OF METAL CHELATES. Bror Skytte Jensen (Danish Atomic Energy Commission, Risø, Denmark). *Acta Chem. Scand.* 13, 1347-57(1959).

A two-phase titration procedure for the study of metal chelate equilibria is presented. Equations expressing the relationship between the apparent mean complexity constant in the two-phase system, the mean complexity constant in a water phase, and the distribution coefficients of the uncharged species are derived. The pH-value of 50% extraction of a metal ion is determined with good approximation by this method. The error introduced by the simplified theoretical treatment is discussed and the predictions are confirmed by independent distribution experiments, employing lanthanum-140 as tracer. (auth)

#### 3571

ON THE COMPLEX CHEMISTRY OF THE TERVALENT RARE-EARTH IONS. IV. ION-EXCHANGE STUDIES OF THE GADOLINIUM ACETATE AND GLYCOLATE SYSTEMS. Artur Sonesson (Univ. of Lund, Sweden). *Acta Chem. Scand.* 13, 1437-52(1959).

The gadolinium acetate and glycolate systems were investigated by means of both cation and anion exchangers. The measurements were performed at 20°C using the radioactive isotope  $\text{Gd}^{153}$ . For the investigation cation exchanger solutions with constant ionic strength  $I = 1.0 \text{ M}$  were used ( $\text{NaClO}_4$  was added). The solutions used for the investigation with the anionic exchanger had varying ionic strength. The complexity constants obtained for both the acetate system and the glycolate system by means of the cation-exchange method are in good agreement with the constants obtained potentiometrically. Anionic complexes, however, could not be proved by the cation-exchange method. The investigation of the glycolate system by means of an anion exchanger confirms the existence of anionic glycolate complexes. The maximum point of the  $\phi$ -curve indicates that  $\bar{n} = 3$  in a water solution having  $[\text{AcOH}] \approx 100 \text{ mM}$ , which is quite in accordance with the potentiometric measurements. The ligand numbers computed from data obtained by the anion exchange method are in good agreement with the ligand numbers obtained potentiometrically in the whole region investigated. Attempts were made to compute the stability constants. According to the measurements with the anion exchanger, no anionic complexes should be formed in the gadolinium acetate system for  $[\text{Ac}^-] < 800 \text{ mM}$ . However, the low  $\phi$ -values may also be caused by steric effects which depress the sorption of the acetate complexes into the exchanger below measurable values. (auth)

#### 3572

SEPARATION OF BORON FROM ALLOYS AND OTHER MATERIALS BY PYROHYDROLYSIS. V. R. Wiederkehr and G. W. Goward (Westinghouse Electric Corp., Pittsburgh). *Anal. Chem.* 31, 2102-3(1959) Dec.

Boron powder is placed in a nickel or platinum boat and steam is passed over the sample at a furnace temperature of 1100°C. The distillate is caught in an alkaline solution and the boron is analyzed by any of the conventional methods. The method is applicable for boron separation from zirconium, Zircaloy, Zircaloy-base uranium alloys, stainless steels, and other materials such as boron carbide. (C.J.G.)



**3573**

A NEW METHOD OF SEPARATION OF RADON. S. Szucs (Université, Louvain, Belg.). Ann. soc. sci. Bruxelles, Ser. III, 72, 138-9(1958). (In French)

A method of purifying radon is offered. The Rn is passed through an evacuated and degassed bell-jar arrangement where Ba is electrically vaporized. The Rn is recovered in a liquid air trap. The operator is exposed for only about 10 min. (T.R.H.)

**3574**

ANION EXCHANGE STUDIES OF BERYLLIUM(II), CERIUM(IV), THORIUM(IV) AND URANIUM(VI) CARBONATE COMPLEX IONS. Seizo Misumi and Tomitsugu Taketatsu (Kyushu Univ., Fukuoka). Bull. Chem. Soc. Japan 32, 876-8(1959) Aug.

The anion exchange behavior of macro amounts of Be, Ce, Th, and uranyl carbonate ions formed in ammonium carbonate solution and tracer amounts of cerium and thorium carbonate complex ions formed in potassium carbonate were studied. Distribution coefficients were measured with the "Dowex 1, X-8" anion exchanger of carbonate form. (C.J.G.)

**3575**

THE SEPARATION OF THORIUM(IV) AND CERIUM(III) IONS BY USING ALGINATE AS CATION EXCHANGER. Takeo Takahashi and Shingto Miyake (Univ. of Tokyo). Bull. Chem. Soc. Japan 32, 878-9(1959) Aug.

A method for the separation of thorium (IV) and cerium (III) by using alginate as ion exchanger and dilute nitric acid as eluant is described. (C.J.G.)

**3576**

CONTINUOUS DISSOLUTION OF URANIUM-ALUMINUM FUELS IN A TRICKLE-TYPE COLUMN DISSOLVER. J. C. Bresee, D. L. Foster, and E. O. Nurmi (Oak Ridge National Lab., Tenn.). Chem. Eng. Progr. 55, Symposium Ser. No. 22, 25-32(1959).

A continuous column dissolver may be operated with critically safe dimensions; hence this type of dissolver may have an unlimited charge of metal per unit, with no theoretical upper limit to the capacity. With the added advantage that a continuous dissolver may better serve a continuous solvent-extraction process than a batch dissolver, the continuous column dissolver is potentially the most satisfactory type for short fuel elements or sections of elements. A study was conducted to investigate the performance of a full-scale continuous dissolver with suitable dimensions for enriched-power-reactor-fuel dissolution and to determine the capacity of this scale of equipment at a specified product concentration. Results on a full-scale continuous trickle-type column dissolver for enriched uranium-aluminum-alloy fuels are presented. Both cast and extruded unirradiated alloys were dissolved, and correlations are given relating dissolving rate and product concentration to feed acid rate and concentration for both types of alloy. The application of the correlations to column design and operation is discussed. (auth)

**3577**

DESIGN OF PLUTONIUM PROCESSING PLANTS. B. F. Judson (Hanford Atomic Products Operation, Richland, Wash.). Chem. Eng. Progr. 55, Symposium Ser. No. 22, 33-6(1959).

A design philosophy for plutonium processing plants is presented. Concepts of the design include the use of contamination barriers made up of sealed hoods and directionalized air flow, partial separation of operating and maintenance functions in the physical layout, inclusion of multicomponent processing systems in single large hoods,

and the considerations necessary for critical mass control. (auth)

**3578**

SEPARATION OF A RARE EARTH FRACTION FROM THE FISSION PRODUCTS OF  $U^{235}$ . V. Knobloch and Z. Urbanec. Compt. rend. congr. intern. chim. ind. 31<sup>e</sup> Congr., Liège, 1958. 3p. (In German)

The use of paper electrophoresis to separate rare earths from  $U^{235}$  fission products is demonstrated. The separation is satisfactory in a buffer solution of 0.2 M citric acid in the pH range 2.2 to 3.0. The sequence and method of identification are indicated for La, Ce, Pr, Nd, Pm, Sm, Y, Tb, and Ho. (tr-auth)

**3579**

EXTRACTION AND SEPARATION OF ZIRCONIUM AND HAFNIUM BY MEANS OF LIQUID ANIONIC EXCHANGERS IN A HYDROCHLORIC ACID MEDIUM. I. BEHAVIOR OF SOME PRIMARY, SECONDARY AND TERTIARY AMINES. E. Cerrai and C. Testa (CISE, Milan). Energia nucleare (Milan) 6, 707-16(1959) Nov.

Some long-chain primary, secondary, and tertiary amines were applied to the extraction and separation of zirconium and hafnium from solutions containing various concentrations of hydrochloric acid. The effect of temperature on extraction and separation factor was also investigated. Extraction is lower at lower temperatures but the separation factor is higher. Almost all the investigated products gave a good extraction of the two elements (zirconium is preferentially extracted) and some of them also significant separation factors. (auth)

**3580**

THE AMEX PROCESS FOR EXTRACTING THORIUM ORES WITH ALKYL AMINES. David J. Crouse, Jr. and Keith B. Brown (Oak Ridge National Lab., Tenn.). Ind. Eng. Chem. 51, 1461-4(1959) Dec.

The Amex processes use long-chain alkyl amines for solvent extraction separation of thorium and by-products from ore sulfate liquors. Because the extraction power for thorium, uranium, and rare earths depends on amine class and alkyl structure, appropriate choice of amine allows separate recovery of these metals in multicycle operations. Chloride, nitrate, and carbonate solutions strip extracted metals from the amine. Thorium recovery was >99.8% with four stages of recovery. (auth)

**3581**

RADIOCHEMICAL EXPERIMENTS: A THORIUM 234 "COW" FOR Pa-234. D. J. Carswell and J. J. Lawrance (Atomic Energy Commission, Lucas Heights, Sydney). J. Chem. Educ. 36, 499-501(1959) Oct.

A method utilizing anion exchange techniques, similar to a method described by Van R. Smit, but using hydrochloric acid and concentrating the thorium on a small cation column is described. It was found that  $Pa^{234}$  could be extracted very efficiently with 40% tri-n-octylamine in xylene and with diisopropyl ether as solvents. (C.J.G.)

**3582**

SEPARATION OF STRONTIUM-90 FROM SOLUTIONS. K. H. Lieser and W. Hild (Technische Hochschule, Darmstadt, Ger.). Naturwissenschaften 46, 599(1959) Nov.

Isotope exchange and ion-exchange experiments were carried out between  $(Sr^{90})^{++}$  ions and solid alkaline earth metal sulfates. The results indicate the possibility of a separation procedure. (T.R.H.)

**3583**

REACTOR FUEL PROCESSING. Technical Progress Review, Vol. 2, No. 4. Lemont, Ill., Argonne National Labo-

ratory, 1959. 48p. \$0.55(GPO)(domestic), \$0.70(GPO) (foreign).

**Commercial Aspects of Fuel Processing.** Plans are presented for processing power reactor fuels at Hanford. Data are reported on AEC and private fuel processing costs. **Preparation for Fuel Processing.** Methods are discussed for the removal of fuel element jackets by mechanical means. Chemical de jacketing processes are presented for the removal of Zr and Zr alloy, stainless-steel, and Al jackets from fuel elements. A flowsheet is presented for the Drexel Process. **Research and Development on Fuel Processing.** In this section research on solvent extraction, precipitation processing, ion-exchange processes, volatility processes, pyrometallurgical processing, homogeneous reactor processing, and corrosion. **Waste Disposal.** A brief discussion is presented on reduction to solids, final disposal methods, and removal of specific isotopes. The production of U, Th, Pu, and their compounds is reviewed. (W.L.H.)

## ENGINEERING AND EQUIPMENT

### General and Miscellaneous

**3584** AECU-4455

Franklin Inst. Labs. for Research and Development, Philadelphia.

**EXTENSION OF THE CONDUCTING SHEET ANALOGY TO EXTERNALLY PRESSURIZED GAS BEARINGS.** Interim Report. Lazar Licht. Oct. 1959. 15p. Sponsored by Dept. of Defense; AEC; and Maritime Administration under Contract Nonr-2342(00). (I-A2049-9). OTS.

Incompressible, viscous flow in narrow passages bounded by parallel surfaces yields the two-dimensional Laplace equation,  $\nabla^2 P = 0$ . The pressure field, load capacity, and lubricant flow of hydrostatic oil bearings can be readily determined by means of the electric analogy of the conducting sheet. The equation  $\partial/\partial x [P(\partial P/\partial x)] + \partial/\partial y [P(\partial P/\partial y)] = 0$  characterizes laminar, isothermal flow of gas lubricants in otherwise geometrically identical bearings. It is shown that by means of suitable change of the dependent variable the above equation can be reduced to the Laplacian form. The ensuing advantage is the extension of the conducting sheet analogy to externally pressurized thrust and journal guide bearings when the lubricant is a gas. (auth)

**3585** WADC-TR-58-638(Vol.I, Pt.I)

Tribo-Netics Labs., Vermilion, Ohio.

**LUBRICATION REFERENCE MANUAL FOR MISSILE AND SPACE VEHICLE PROPULSION AT TEMPERATURES ABOVE 700°F.** Period covered: June 1958 to January 1959. Fred Macks. Jan. 1959. 498p. Project title: AVIATION LUBRICANTS. Task title: MISSILE AND SPACE VEHICLE PROPULSION LUBRICANTS. Contract AF33(616)-5982. (AD-213474).

A survey, study, and analysis of high temperature (above 700°F) lubrication, friction and wear requirements, and problems relating to primary and secondary propulsion systems of missiles, satellites, and space vehicles was made. The results of this investigation are presented in this Manual (Volume I) and Volume II. The latter is classified. Requirements, problems, and data associated with relatively moving surfaces for missile, satellite, and space propulsion at temperatures above 700°F are given. The criteria whereby information was selected include secondary and primary propulsion requirements, and lubricant applications above 700°F. (auth)

**3586**

**MEASURING OIL CONSUMPTION WITH TRITIUM TRACERS.** Vincent P. Guinn and R. A. Coit (Shell Development Co., Emeryville, Calif.). *Nucleonics* 17, No. 12, 112-15; 17(1959) Dec.

A method of measuring automobile-engine oil consumption by tritium tracers and liquid-scintillation counting is capable of measuring rates as low as 0.1 ml/mile. The liquid-scintillation counting method and the weight-loss method of measuring oil consumption are described and compared. (C.J.G.)

**3587**

**A COURSE IN HIGH VACUUM TECHNOLOGY.** C. L. Gould (Brookhaven National Lab., Upton, N.Y.). p.105-9 of "1958 Fifth National Symposium on Vacuum Technology Transactions."

A program syllabus for a course in high vacuum technology is presented. The course is slanted toward the physicists and engineers who are responsible for the design philosophy of vacuum equipment. A course in leak detection for technicians is included. (W.D.M.)

**3588**

**1958 FIFTH NATIONAL SYMPOSIUM ON VACUUM TECHNOLOGY TRANSACTIONS, OCTOBER, 22, 23, 24, HOTEL SIR FRANCIS DRAKE, SAN FRANCISCO, CALIFORNIA, U.S.A.** Wilfrid G. Matheson, ed. New York, Pergamon Press, 1959. 290p.

The Fifth National Symposium on Vacuum Technology was held in San Francisco, Oct. 1958. A broad spectrum of papers was presented in the categories of fundamental basis of vacuum techniques, applied science and research, vacuum systems and components, vacuum instrumentation and controls, education in vacuum technology, ultra high vacuum, vacuum deposited magnetic and thin films, and industrial applications and processes. (W.D.M.)

**3589**

**THE EVAPORATION OF VARIOUS ALLOYS AT HIGH TEMPERATURE IN VACUO.** W. A. Blonn (General Electric Co., Shelbyville, Ind.). p.30-4 of "1958 Fifth National Symposium on Vacuum Technology Transactions."

The rates of evaporation of alloys at elevated temperatures in vacuum are dependent upon the temperature only when the pressure is less than 100  $\mu$ . Coupons of materials intended for use in vacuum furnace construction were subjected to temperatures up to 2280°F in vacuums of 0.1 to 10  $\mu$ . Rates of evaporation range from  $4.7 \times 10^{-3}$  for 80 Ni-20 Cr to  $1.2 \times 10^{-2}$  g/cm<sup>2</sup>hr for type 430 stainless steel. All alloys tested roughly follow the rule of thumb that a 10% increase in temperature causes a one decade increase in evaporation rate. (auth)

**3590**

**MECHANISM OF EVOLUTION OF GASES FROM LIQUID METAL UNDER VACUUM.** A. M. Samarin and R. A. Karasev (Academy of Sciences, USSR). p. 35-7 of "1958 Fifth National Symposium on Vacuum Technology Transactions."

One of the main advantages of using vacuum in steel making is that the metal is deoxidized more completely by carbon. The oxygen isotope, O<sup>18</sup>, was used in an investigation to study the features of the mechanism of evolution of the oxygen dissolved in the liquid metal. The Fe-C-O<sup>18</sup> alloys were prepared by melting pure electrolytic iron and keeping it within the temperature interval 1580 to 1630°C first in an atmosphere of dry hydrogen and then in one of a hydrogen-steam mixture containing H<sub>2</sub>O<sup>18</sup>. The carbon was introduced into the metal as a synthetic Fe-C alloy after saturating the metal with O at a given H<sub>2</sub>O/H<sub>2</sub> ratio. (W.D.M.)



**3591**

VACUUM SYSTEM FOR THE CAMBRIDGE ELECTRON ACCELERATOR. Roger L. Hall (Harvard Univ., Cambridge, Mass.). p.41-3 of "1958 Fifth National Symposium on Vacuum Technology Transactions."

Special problems such as eddy currents, small pumping aperture, and radiation damage have been encountered in the design of the vacuum system for the 6 Bev electron accelerator now being built as a joint effort of Massachusetts Institute of Technology and Harvard University. Proposed solutions to these problems and the result of measurements on model vacuum chambers and pumping systems are discussed. (auth)

**3592**

SIMPLE OUTGASSING DETERMINATIONS AID HIGH TEMPERATURE VACUUM BRAZING. E. G. Huschke, Jr. (General Electric Co., Cincinnati). p.50-7 of "1958 Fifth National Symposium on Vacuum Technology Transactions."

Certain of the alloys employed in jet engines, nuclear reactors, and other critical high temperature components because of their nature or of certain alloying additions cannot be successfully brazed in normal dry hydrogen. Data are presented relating the past two years' work to determine the feasibility and maximum pressure tolerance for vacuum brazing certain of these materials. A quantitative measure of gas evolution from several selected materials and brazing alloy powders during a brazing cycle were determined in a gas fusion analyzer. These data are correlated with the maximum pressure determinations to yield a required pumping speed during the most critical portion of the brazing cycle. Sample data and calculations are included. (auth)

**3593**

PREPARATION OF TARGETS FOR ACCELERATORS. B. J. Massey (Oak Ridge National Lab., Tenn.). p.72-5 of "1958 Fifth National Symposium on Vacuum Technology Transactions."

The fabrication of targets for accelerators is discussed as to preparation and characteristics of target backing for minimum background count as well as mechanical fitness, design of directional filaments to transfer the largest amount of charged material to the target and to withstand attack by material being evaporated, target rotation during evaporation to form uniform films, accurate prediction and assay of film thickness, effect of varying the time of evaporation, and minimizing impurities in the evaporated film by use of a shutter. Modifications to conventional equipment are shown and discussed. Gas-handling techniques are discussed for impregnating tritium-zirconium targets. (auth)

**3594**

AN ELECTRON BOMBARDMENT FURNACE FOR THE PRODUCTION OF VACUUM-MELTED METALS. E. S. Candidus and J. C. Simons, Jr. (National Research Corp., Cambridge, Mass.). p.86-8 of "1958 Fifth National Symposium on Vacuum Technology Transactions."

A furnace for the production of electron bombardment melted metals is described. Incorporated in the furnace design are several features that eliminate arcs and glow discharges which might hamper the melting operation or damage the electron source. The furnace design also permits the use of a relatively inexpensive pumping system. (auth)

**3595**

THE USE OF COPPER FOIL ISOLATION TRAPS WITH ULTRA-HIGH VACUUM SYSTEMS. J. H. Carmichael and W. J. Lange (Westinghouse Research Labs., Pittsburgh).

p.137-9 of "1958 Fifth National Symposium on Vacuum Technology Transactions."

Copper foil isolation traps have been used in conjunction with oil diffusion pumps for many years to achieve pressures below  $10^{-8}$  mm Hg. The mechanism whereby copper prevents back-streaming products from reaching the vacuum system is not completely understood. Performance characteristics of some of the factors important to the trapping process were measured and are discussed. (auth)

**3596**

SOME COMPONENT DESIGNS PERMITTING ULTRA-HIGH VACUUM WITH LARGE OIL DIFFUSION PUMPS. Norman Milleron (Univ. of California, Livermore). p.140-7 of "1958 Fifth National Symposium on Vacuum Technology Transactions."

A new high conductance L-N trap and baffle design 7 in. thick that may scale up radially for the largest oil diffusion pumps was tested. Pressures of  $\sim 5 \times 10^{-10}$  mm Hg are observed using this trap and baffle design with 4 in. oil diffusion pumps. Using a special system with a volume of 70.1 and a base pressure  $< 1 \times 10^{-10}$  mm Hg, system pumping speeds are measured by employing the evacuation rate method. Speed measurements for the gases He and Ne of 101 l./sec and 46 l./sec respectively, are observed over the range  $1 \times 10^{-4}$  through  $1 \times 10^{-9}$  mm Hg when using this trap and baffle design above a Consolidated MCF 300 stainless steel diffusion pump using oct-oil "S". A compression copper gasket design especially suited for large vertical flanges is given. Results with metal gaskets of 2 to 37 in. diam are given. Remarks are included on large-aperture isolation valves. Some general procedures that have yielded pressures  $< 10^{-8}$  mm Hg in large systems are given. (auth)

**3597**

THE PRODUCTION AND MEASUREMENT OF ULTRA-HIGH VACUUM ( $10^{-8}$ – $10^{-13}$  mm Hg). P. A. Redhead (National Research Council, Ottawa). p.148-52 of "1958 Fifth National Symposium on Vacuum Technology Transactions."

Methods are described for producing pressures as low as  $10^{-13}$  mm Hg in glass systems by liquid helium trapping and ion pumping. Factors limiting the ultimate pressure are discussed. The construction and operation of two new types of vacuum gauges capable of measuring pressures in the range from  $10^{-4}$  to  $10^{-13}$  mm Hg are described. (auth)

**3598**

ELECTRON BOMBARDMENT MELTING, A HIGH VACUUM TECHNIQUE APPLIED TO METALLURGY. Hugh R. Smith, Jr., Charles D'A Hunt, and Charles W. Hanks (Temescal Metallurgical Corp., Richmond, Calif.). p.164-7 of "1958 Fifth National Symposium on Vacuum Technology Transactions."

Utilization of the basic technique of obtaining high temperature by electron bombardment on a practical scale from a metallurgical scale requires a unique combination of high vacuum technique and electronic control. Pertinent system parameters are described. (W.D.M.)

**3599**

AUTOMATIC LIQUID AIR DISTRIBUTION SYSTEM FOR LARGE SCALE HIGH VACUUM PUMPING SYSTEMS. N. Ochert and T. A. Heppell (Edwards High Vacuum, Ltd., Crawley, Eng.). p.247-53 of "1958 Fifth National Symposium on Vacuum Technology Transactions."

A system is described for automatic maintenance of the numerous liquid air traps protecting a clean, extensive, high vacuum installation, from vapor pump fluid contamination. Small air liquefiers, switched in automatically,

supply distributors containing one liquid air delivery pump for each trap. Commercial Dewars are connected as reservoirs and allow for liquefier defrosting or other stoppage. Adequately insulated transfer lines of considerable length lead to each trap. Control is effected by a liquid level sensitive switch in each trap, distributor and reservoir, actuated by preset upper and lower levels. The whole system is interconnected and allocates appropriate priorities in operation. (auth)

## Heat Transfer and Fluid Flow

**3600** AECU-4328

Iowa. State Univ., Iowa City.

FLOW THROUGH MICROPOROUS MEDIA VAPOR TRANSFER THROUGH BARRIERS. Lenard O. Rutz and Karl Kammermeyer. July 1959. 54p. Contract AT(11-1)-237. OTS.

The flow of helium, hydrogen, methane, ethene, propene, and propane was investigated with porous Vycor glass as a barrier. Adsorption isotherms for the alkenes and alkanes, as well as for carbon dioxide were determined. The adsorption data could be correlated by means of the two-dimensional compressibility factor or by various forms of a Polanyi potential. The transport of helium and hydrogen occurred by Knudsen flow. The transport of alkenes and alkanes involved varying degrees of adsorbed or condensed flow, so that the mechanism could not be described by a Fick's Law diffusion process. The flow of the respective adsorbates could be correlated by plotting adsorbate diffusivities against the average relative pressure. Similar correlations were established by using flow models involving the spreading pressure potential of a two-dimensional fluid, and also the capillary number concept. Individual correlations gave reasonably good agreement among flow data of one or more compounds. However, a satisfactory correlation which would interpret the flow mechanism of all gases and vapors is still to be developed. (auth)

**3601** CF-59-5-87

Oak Ridge National Lab., Tenn.

BRIEF REVIEW OF HEAT TRANSFER PROBLEMS ENCOUNTERED IN THE PRODUCTION OF MAGNETIC FIELDS. L. G. Alexander. May 25, 1959. 11p. OTS.

The design of internally cooled electrical coils for the production of high intensity magnetic fields presents many new aspects and combinations of the familiar modes of heat transfer. However, the customary methodology appears to be sufficient for preliminary analysis and understanding of those problems. This methodology comprises the derivation of a qualitative, approximate equation expressing the relative performance of the various parts of a system, followed by an examination of this equation in order to locate the limiting features of the system. These features are then investigated by more powerful methods, which in turn provide guidance for development research in the laboratory. (auth)

**3602** WADC-TN-57-350

Brown Univ., Providence.

THERMODYNAMICS OF ELECTRICALLY CONDUCTING FLUIDS AND ITS APPLICATION TO MAGNETOHYDROMECHANICS. Boa-Teh Chu. Dec. 1957. 35p. Project No. 7(8-1366). Contract AF33(616)-2798. (AD-142039).

By consideration of the equations of motion and the electromagnetic theory of a moving medium, the reversible work done on a fluid, per unit mass, in a small change of state is shown to be  $-\rho d(1/\rho) + \vec{E} \cdot d(\vec{D}/\rho) + \vec{H} \cdot d(\vec{B}/\rho)$  where  $p$  is the pressure due to the joint action of the mechanical

and electromagnetic changes;  $\rho$  is the density;  $\vec{E}$  and  $\vec{B}$  are, respectively, the electric field strength and magnetic induction;  $\vec{D}$  and  $\vec{H}$  are, respectively, the electric and magnetic excitation. Only the non-relativistic version of Minkowski's theory was used in this derivation. This formula provides the basis for a complete study of the thermodynamics of fluid medium under the action of both electromagnetic and mechanical changes. As an application, basic formulas which may be used to calculate the electrocaloric effect, the magnetocaloric effect, and electro- and magnetostriction effects are deduced. In particular, the additional pressure and pondermotive force due to these effects are obtained in a simple manner which, from the thermodynamic point of view, is better than Kortweg and Helmholtz' derivation given in the classical electromagnetic theory. As a second application, the energy equation of magneto-hydrodynamics is derived. The derivation is more general than previous derivations in that it does not presuppose the form of the electromagnetic constitutive equations which the medium satisfies. (auth)

**3603**

APPLICATIONS OF MAGNETOFLUIDMECHANICS. Theodore von Karman (Agard, Paris). *Astronautics* 4, No. 10, 30; 86(1959) Oct.

The application of magnetofluidmechanics to fluid flow modification by high magnetic fields or artificial increase of the conductivity, to containment electromagnetically, and to various fluid propulsion methods is discussed. (C.J.G.)

**3604**

HEATING OF A HEAT-CONDUCTING WALL BEHIND A MOVING DENSITY JUMP. G. A. Tirsksii. *Doklady Akad. Nauk S.S.S.R.* 128, 1140-3(1959) Oct. 21. (In Russian)

Equations are derived for describing the heating in a heat-conducting wall behind a moving density jump, with constant velocity parallel to the boundary, in a static gas (R.V.J.)

**3605**

HEAT TRANSFER PROPERTIES OF SANTOWAX R.

C. Grove-Palmer and H. Pass (Atomic Energy Research Establishment, Harwell, Eng.). *Nuclear Power* 4, No. 44, 118-21(1959) Dec.

Unpolymerized Santowax R (commercial name of an isomeric mixture of terphenyl) in the absence of radiation can be operated at bulk fluid temperature up to 400°C in contact with a heated surface at a temperature up to 520°C without any fouling of the heated surface, provided that adequate flow is maintained. It is shown that the standard Dittus and Boelter equation  $Nu = 0.023 Re^{0.8} Pr^{0.4}$  can be used to correlate heat transfer data for Santowax R. This equation is preferred to the one proposed by Bley and shows good agreement with the results reported even with the much higher heat fluxes which were obtained in the present experiments. Burnout heat flux values slightly higher than the values suggested by the Griffith correlation were obtained, and it is considered that the Core and Sato correlation can be used to predict burnout heat flux more closely. These indicate that a heat flux of 300 watts/cm<sup>2</sup> can be safely sustained when the bulk fluid temperature is 350°C with a fluid velocity of 20 ft/sec and 100 lb/in.<sup>2</sup> system pressure. (auth)

**3606**

PROCEEDINGS OF THE SIXTH MIDWESTERN CONFERENCE ON FLUID MECHANICS, [HELD AT] THE UNIVERSITY OF TEXAS, AUSTIN, SEPTEMBER 9-11, 1959. Austin, Texas, The University of Texas, 1959. 472p.

The thirty papers presented at this conference include:



recent progress in Rarefied Gas Dynamic Research; Laminar Heat Transfer to the Stagnation Line Region of a Highly Yawed Cylinder; An Extended Reynolds Analogy; Determination of Connective Heat Transfer to Non-isothermal Surfaces Including the Effect of Pressure Gradient; Steady State Fusible Body Shapes in a Heated Supersonic Stream and Hypersonic Stream; Secondary Flow in Straight Open Channels; Variation of the Wind Profile with Meteorological Parameters; Spherical Explosions in Sea Water; Spectral Relations in Homogeneous Turbulence of an Incompressible Fluid; The Blade Frequency Velocity Field Near an Operating Marine Propeller Due to Loading and Thickness Effects; Turbulent Plane - Couette Flow; Virtual Mass and Slender-body Theory for Bodies in Waves; Flow Characteristics of a Circular Submerged Jet Impinging Normally on a Smooth Boundary; Tangent Flows; Laplace Transformation Solution of Simultaneous Linear Flow in Two Regions Separated by a Fixed Boundary; Hypersonic Flow Around Bodies of Revolution Which are Generated by Conic Sections; An Approximate Theory for the Pressure Distribution and Wave Drag of Bodies of Revolution at Mach Number One; Particulate Dynamics Research at Sandia Laboratory; Film Characteristics and Dimensions in Annular Two-phase Flow; Temperature Determinations of Methane-air Combustion Products by Velocity-of-Sound Measurements; An Electro-mechanical Transducer for Measuring Dynamic Pressures of Fluids; The Organized Boundary Layer; Measurement of Local Skin Friction by Means of a Surface Probe in Cases of Low Speed Turbulent Flow over a Porous Flat Plate with Mass Injection; Scale Effects in Turbulent Shock Wave Boundary Layer Interactions; The Gas Lubricated Finite Slider Bearing; The Hydrodynamic Lubrication of Sector Thrust Bearings; Theoretical and Experimental Study of Heat Transfer by Cellular Convection in the Presence of Impressed Magnetic Fields; Canonical Forms, Beltrami Flows and Certain Exact Solutions in Magneto-Gas-Dynamics; The Wave Motions of Small Amplitude in Radiation-Electro-Magneto-Gasdynamics; and Further Results on the Flow of a Conducting Fluid Past a Magnetized Sphere. (W.L.H.)

## Instrumentation

### 3607 AD-212410

Mare Island Naval Shipyard. Industrial Lab., Calif. DEVELOPMENT OF A PROCEDURE FOR CALIBRATING A WELL-TYPE SCINTILLATION DETECTOR FOR THE MEASUREMENT OF ABSOLUTE RADIOACTIVITY. Paul T. Wagner and Louis R. Pollack. 1957. 23p.

A procedure is described for obtaining the relationship between counts per minute and disintegrations per minute, using a wall-type scintillation crystal which is considered, from a geometrical standpoint, as completely surrounding the radioactive sample in the test tube. Attenuation losses through the crystal wall are calculated using an empirical thickness which gives the correct result with standard samples. The decay schemes of the radionuclides must be known, and losses due to coincident attenuations, in the case of more than one photon emission per disintegration, must be taken into account. Conversion factors are listed for eleven radioisotopes, in addition to a mean conversion factor for obtaining an estimate of absolute radioactivity when the concentration and identities of the radioisotopes present are not known. The method is applicable to any radionuclide with a known decay scheme which emits a predominant gamma ray of 0.24 Mev or greater energy. (auth)

### 3608 AECU-4505

Illinois. Univ., Urbana. Digital Computer Lab. ON THE DYNAMIC DESIGN OF NON-REGENERATIVE TRANSISTOR CIRCUITS. Report No. 94. Toshiro Kunihiro. Nov. 19, 1959. 41p. Contract AT(11-1)-415. OTS.

The transfer function of a non-regenerative, base-driven circuit is derived by applying the linear equivalent circuit method and the results are experimentally verified. The idea of the inverse-gain-bandwidth is introduced as the criterion of the dynamic design and the stability factor is explained. It is shown that a system constructed by various types of transistor switching circuits is reduced to a long train of unit chains formed by delay units and wave shapers, and the maximum allowable number of delay units in a unit chain is discussed. (W.D.M.)

### 3609 AERE-R-2962

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England. A MICROSECOND TIME TO AMPLITUDE CONVERTER—A.E.R.E. TYPE NO. 1608A. F. H. Wells and A. K. Barlow. Aug. 1959. 14p. BIS.

An instrument is described which was designed to enable time interval measurements to be made in the ranges up to 100  $\mu$ sec when used in conjunction with a multichannel pulse amplitude analyzer. The instrument produces a rectangular output pulse, with an amplitude proportional to the time difference between "start" and "stop" input pulses, corresponding to the limits of the time interval being measured. (W.D.M.)

### 3610 AERE-R-3035

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England. AUTOMATIC RECORDING SYSTEMS FOR USE WITH A HIGH DISPERSION SPECTROGRAPH. E. W. T. Richards and M. D. Crew. Aug. 1959. 18p. BIS.

Design of photoelectric recording systems for use in conjunction with high dispersion spectrographs is discussed. Methods by which direct recording may be achieved are examined. One such method is to quickly scan the spectrum across the entrance slit of a photomultiplier assembly, and displaying the signals on an oscilloscope. An alternative is to move the spectrum slowly across the entrance slit of the photomultiplier assembly and display the amplified signals on a pen chart recorder. Each of these methods is described. Diagrams are included. (J.R.D.)

### 3611 AFOSR-TN-59-738

New York Univ., New York. Coll. of Engineering. PLATEAU SLOPES AND PULSE CHARACTERISTICS OF LARGE, HIGH-PRESSURE  $\text{BF}_3$  COUNTERS. Rosalind B. Mendell. July 1959. 77p. Project No. 9751. Contract AF18(600)-1555.

Factors affecting the flatness of plateau of large diameter high-pressure  $\text{BF}_3$  counters were examined. It was found that with gas and counter body free from contamination, counters up to 5 cm radius and filled with  $\text{BF}_3$  gas at 64 cm Hg had acceptably flat plateaus. Desired gas purity was obtained by generating the gas from  $\text{CaF}_2\text{BF}_3$  complex, trapping residual impurities, and isolating and collecting  $\text{BF}_3$  vapor that had been in equilibrium with the liquid phase at a vapor pressure of 20 cm Hg. The resolution of counters of different pressures and cathode diameter for ionizing events with a known energy spectrum was compared. Specifically, the energies examined

were those resulting from the reactions  $B^{10}(n,\alpha)Li^7$  and  $B^{10}(n,\alpha)Li^{1*}$ . The effect of increasing pressure and counter diameter on measured pulse amplitude correlated with previous reports that electron attachment in  $BF_3$  gas exists and increases with p/E. A rough estimate of capture cross section from the maximum of the pulse amplitude distributions in the various counters indicated a value of capture cross section smaller than that previously obtained. It was inferred that part of the capture cross section previously attributed to  $BF_3$  may have resulted from electronegative impurities such as  $SiF_4$  and  $SO_2$ . Pulse amplification characteristics of the different counters were determined, and results, including the effect of electron attachment on measured values for counters of large diameter and high pressure are discussed. (auth)

**3612** CF-58-1-20(Rev.)

Oak Ridge National Lab., Tenn.

NOTES ON HELIUM LEAK DETECTION. H. J. Metz. July 10, 1959. 30p. OTS.

A collection of information on the use of mass-spectrometer-type helium leak-detectors is presented. Included is information on detector sensitivity, use of standard and calibrated leaks, methods of detection and measurement of leaks, and operation of various standard leak detectors. (J.R.D.)

**3613** HW-56128(Rev.)

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

AN AURAL ALPHA-BETA-GAMMA MONITOR. W. G. Spear and G. D. Crouch. May 1, 1959. 17p. Contract W-31-109-Eng-52. OTS.

Circuit improvements and probe modifications incorporated in the equipment described in HW-56128 to provide more reliable operation and simpler maintenance are presented. The necessary modifications were determined through nine months use of the original experimental unit. The instrument indicates alpha radiation by one distinct aural signal, and it indicates beta-gamma radiation by a second distinct aural signal. (W.D.M.)

**3614** HW-56151(Rev.)

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

A STACK EFFLUENT RADIOISOTOPE MONITOR. R. A. Harvey. Oct. 15, 1958. 36p. Contract W-31-109-Eng-52. OTS.

A system for simultaneously measuring and indicating each of several different radioisotopes in the stack effluent of an atomic energy facility is described. Analog computer techniques are employed for the solution of simultaneous equations and for the counting and scaling. Two presentations are included for the output. The total amounts of the radioisotopes emitted to the atmosphere are indicated on registers, and marks are recorded on a moving chart each time specific quantities are emitted. The emission quantity of each isotope is indicated by a register and single channel on the chart recorder. (auth)

**3615** HW-56487(Rev.)

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

MEDIUM-LEVEL CONTINUOUS ALPHA AIR MONITOR. M. O. Rankin. June 1, 1959. 27p. Contract W-31-109-Eng-52. OTS.

A continuous alpha air monitor was developed which can detect an airborne concentration of 75 mpc in 18 min or 1000 mpc in 1.5 minutes when the air flow through a molecular membrane filter is 3 cu ft/min. A standard man

in the monitored region would retain approximately 0.03% of his lifetime maximum permissible amount of insoluble plutonium in the lungs if the airborne plutonium concentration suddenly increased to about 75 mpc and the man left the area when the system alarmed. (auth)

**3616** NP-8105

Case Inst. of Tech., Cleveland.

A NUCLEAR MAGNETIC RESONANCE SPECTROMETER (thesis). Technical Report No. 1. Perry R. Longaker. May 1959. 54p. Contract NONR-1141(07).

The construction of a Pound type nuclear magnetic resonance absorption spectrometer is described. Calibration and operation procedures at radio frequency fields of 1 to 2 megacycles and magnetic fields of about 7500 gauss are discussed, utilizing proton resonance in mineral oil and the lithium resonance in various compounds. (auth)

**3617** NP-8106

Case Inst. of Tech., Cleveland.

A TRANSISTOR REGULATED POWER SUPPLY FOR A HIGH CURRENT MAGNET (thesis). Technical Report No. 2. Kenneth C. Brog. Aug. 1959. 41p. Contract NONR-1141(07).

Current regulation of a high-current electromagnet utilizing power transistors in series is described. A sampling voltage, obtained from a sensing resistor in series with the magnet, is compared with a reference voltage. The error signal is sufficiently amplified and fed back to the series transistors through a two-stage transistor driver. Magnet fields from 845 to 8550 gauss with field regulation of a few ppm over this range were obtained. (auth)

**3618** NYO-8911

Alloy Research Corp., Watertown, Mass.

DEVELOPMENT OF AN INSTRUMENT AND TECHNIQUE UTILIZING CARBON-14 FOR MEASURING VERY LOW CONCENTRATIONS OF OXYGEN IN HIGH PURITY METALS. Quarterly Status Report No. 3 [for] Period August 1, 1959 through October 31, 1959. Roger A. Covert. Nov. 25, 1959. 8p. Contract AT(30-1)-2335. OTS.

Research and development work on an apparatus for determining oxygen in metals is reported. Carbon-14 is used in a fusion bath with unknown samples and the carbon oxide gases are determined by counting. Modifications to the apparatus are described and preliminary results are given. In an analysis of NBS steel containing 20 ppm O results of 0.49, 0.43, 0.46, and 0.40 ppm were recorded. While the error is large, it is relatively constant, and ways to improve accuracy are planned. (J.R.D.)

**3619** RIB-42

David Sarnoff Research Center, Princeton, N. J.

DEVELOPMENT OF HIGH SPEED ELECTRON ACCELERATOR STRUCTURES. Interim Report No. 9. J. A. Baicker, A. H. Sommer, and G. O. Fowler. Oct. 31, 1959. 16p. Contract AT(30-1)-1958. OTS.

Several models of the new high speed central electrode photomultiplier were tested. The latest speed measurements of these tubes are given. Some refinements in the method of operation of the beam deflection coincidence tube were made; these resulted in considerably higher ultimate time resolution; the shortest coincidence resolution obtained using mercury switch pulses was  $5 \times 10^{-12}$  sec. Consideration is given on the effect of transit time through the deflection plates on the fast rise pulses from either the mercury switch pulser or the new high-speed photomultiplier. Several low dark current photomultipliers containing guard rings around all anode supports and leads were constructed. (W.D.M.)



**3620 SCTM-108-55-53**

Sandia Corp., Albuquerque, N. Mex.

**STANDARD TEST PATTERN FOR PRINTED WIRING**

CARDS. R. P. Noble. May 23, 1955. 5p. OTS.

A standard test pattern for printed wiring cards is illustrated. The purpose and use of this test pattern are explained. (auth)

**3621 SCTM-150-58(51)**

Sandia Corp., Albuquerque, N. Mex.

**PROJECT DeHENRY, THE STUDY OF A NEW TYPE OF EXPLOSIVE-TO-ELECTRIC TRANSDUCER.** G. W. Anderson and S. E. Whitcomb. July 16, 1958. 109p. Contract AT(29-1)-789. OTS.

The basic principles of a proposed new type of one-shot explosive-to-electric transducer are outlined. The essential operation involved is the forcible reduction of the inductance of a current-carrying circuit, hence the name "Project DeHenry." The DeHenry device promises to be competitive with ferroelectric and ferromagnetic explosive-to-electric transducers in volume economy of energy output (~1 joule/cm). Work to date, outlined herein, includes a survey of similar previous work, a survey of possible geometries, derivation of the governing differential equations, solution of the equations for some special cases, and a beginning of experimental work on the numerous practical problems involved. The most serious practical problem encountered so far is that of controlling shock waves. (auth)

**3622 SCTM-181-59(16)**

Sandia Corp., Albuquerque, N. Mex.

**CERTIFICATION OF FIVE-DIAL WHEATSTONE BRIDGES.** G. R. Fahrbach. Dec. 1, 1959. 24p. OTS.

A procedure for certification of five-dial Wheatstone bridges complete with precertification maintenance procedures, steps for measuring resistors, and residual resistances in ratio arms is described. Methods of calculating and reporting corrections, diagrams and explanations for making circuit connections, and a selected bibliography are given. (auth)

**3623 SCTM-315-59(16)**

Sandia Corp., Albuquerque, N. Mex.

**ZERO SHIFT IN PIEZOELECTRIC TRANSDUCERS.**

Paul E. Scarborough, Jr. Oct. 5, 1959. 16p. OTS.

A problem often encountered in the instrumentation of shocks with piezoelectric transducers is an apparent shift of the d-c reference axis from the normal zero position. High-level shocks along a transverse axis of the accelerometer cause the piezoelectric element to move slightly. Roughness of contact surfaces changes the forces applied to various areas so that a change of potential gradient remains after movement, and a positive or negative d-c voltage appears at the recorder and decreases exponentially back to the normal position as the bound charge is neutralized. The discussion describes extensive tests on Endevco Models 2213, 2214, and 2215, Glennite Model A314T, and CRL Model 606 accelerometers. A detailed explanation of all phenomena encountered is given. A discussion of the factors not influencing the shift is included. (auth)

**3624 SCTM-326-59(2)**

Sandia Corp., Albuquerque, N. Mex.

**AN ELECTROLUMINESCENT TRANSDUCER.** L. C. Meyer. Aug. 28, 1959. 44p. OTS.

A study was made to determine some of the characteristics of electroluminescence and the feasibility of using electroluminescent transducers for converting electrical timing signals to an optical image. (auth)

**3625 UCRL-8706**

California. Univ., Berkeley. Lawrence Radiation Lab. **PROCEEDINGS OF THE SECOND SYMPOSIUM ON ADVANCES IN FAST-PULSE TECHNIQUES FOR NUCLEAR COUNTING, HELD AT THE ERNEST O. LAWRENCE RADIATION LABORATORY, BERKELEY, CALIFORNIA, FEBRUARY 12-13, 1959.** 134p. OTS.

The symposium was organized to exchange and evaluate recent information, to explore the need for future study in the fractional-microsecond field of nuclear counting, and to consider photosensitive devices and pulse techniques. Generally the discussion was limited to the developments of the past two years. (W.L.H.)

**3626 UCRL-8706(p.1-7)**

California. Univ., Berkeley. Lawrence Radiation Lab. **MULTIPLIER PHOTOTUBE TESTING.** Frederick A. Kirsten. 7p.

Some of the methods and results of multiplier phototube tests are described. One of the most useful tools in phototube testing is the mercury-capsule light pulser. The construction and operation of this device is given. The noise and light generation of phototubes are discussed in detail. The time-resolution qualities of phototubes are also discussed. (W.L.H.)

**3627 UCRL-8706(p.8-12)**

Westinghouse Electric Corp. Research Labs., Pittsburgh. **THE APPLICATION OF TRANSMISSION SECONDARY-ELECTRON EMISSION IN SCINTILLATION TRACK IMAGE COUNTERS AND FAST-RISE-TIME PHOTOMULTIPLIERS.** Arthur E. Anderson. 5p.

The phenomenon of transmission secondary-electron emission in thin films offers important advantages over present techniques in amplifying weak photoelectric current generated by light emission from scintillators used in high-speed pulse counting and scintillation track imaging. A schematic diagram is presented of the transmission secondary-emission direct-view image intensifier. In this tube, electron multiplication takes place in a number of plane parallel vacuum-spaced thin-film dynodes. A fast-rise-time photomultiplier is realized by using a similar plane parallel arrangement of thin film dynodes and a coaxial collector in place of the phosphor. (W.L.H.)

**3628 UCRL-8706(p.13-19)**

Radio Corp. of America. RCA Labs., Princeton, N. J. **HIGH-SPEED PHOTOMULTIPLIERS AND ELECTRONIC DEVICES.** George A. Morton. 7p.

A new multiplier with better time-resolution capabilities than conventional multipliers is being developed. The photomultiplier tube is an 11-stage type. Beam-deflection coincidence tubes are discussed along with time dispersion equations and operation of beam coincidence systems. The 3-stage intensifier orthicon is discussed in relation to scintillation track imaging. (W.L.H.)

**3629 UCRL-8706(p.20-3)**

Laboratoires d'Electronique et de Physique Appliquées, Paris.

**DESIGN AND PERFORMANCE OF PHOTOTUBES INTENDED FOR NUCLEAR PHYSICS APPLICATIONS.** Georges Pietri. 4p.

Several specially designed photomultiplier tubes have been designed by the Laboratoires d'Electronique et de Physique Appliquées, Paris, France (LEP). These tubes contribute to the accuracy of detection in two ways: by a small rise time of anode current when excited by a light discontinuity; and by delivering this pulse at a high enough current level to attain a signal output of several volts across a low impedance, thus making unnecessary further

electronic amplifiers. There are two types of LEP photomultipliers for physical research. Laboratory type 204 (commercial type 56 AVP) has a useful cathode diameter of 1.60-in. while laboratory type 206 has a cathode diameter of 4.33-in. Both use the same multiplier section. (W.L.H.)

**3630 UCRL-8706(p.24-8)**

Pennsylvania. Univ., Philadelphia.

A MILLIMICROSECOND LIGHT SOURCE. Albert L. Whetstone. 5p.

A fast light pulse can be produced by pulsing reverse current through a suitable silicon p-n junction. The light covers a range of photon energies from 1 to 3 ev. The immediate application is the testing of photomultiplier tubes, and, since any number of the junctions can be pulsed simultaneously, a method is available for lining up experiments in which large numbers of scintillators and coincidence circuits are used. (auth)

**3631 UCRL-8706(p.29-30)**

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

THE USE OF ELECTROSTATIC STORAGE TUBES FOR FAST NUCLEAR-DATA STORAGE. Frank H. Wells. 2p.

An electrostatic storage tube which can accept, analyze, and record data quickly during the period of one accelerator pulse is described. After the pulse all the stored data are taken from the storage tube and recorded on a more permanent type of instrument, such as a magnetic-tape store. The storage tube is then ready to accept information from the next accelerator pulse. (W.L.H.)

**3632 UCRL-8706(p.31-6)**

National Bureau of Standards, Washington, D. C.

ANALYSIS OF MILLIMICROSECOND PULSES BY USE OF A CHARGE-STORAGE TYPE OF PULSE-HEIGHT ANALYZER. Louis Costrell and R. E. Breuckmann. 6p.

Work is reported on a charge-storage type of pulse-height analyzer for use with pulsed accelerators, with the intention of producing an analyzer that can handle several pulses in a single short burst. (W.L.H.)

**3633 UCRL-8706(p.37-41)**

Massachusetts Inst. of Tech., Cambridge.

REVIEW OF IMAGE INTENSIFIERS. David O. Caldwell. 5p.

A block diagram is presented of the necessary components of a scintillation chamber system, showing both of the optical couplings and image intensifiers. A review is presented of light-amplifying systems. (W.L.H.)

**3634 UCRL-8706(p.42-5)**

Michigan. Univ., Ann Arbor.

LUMINESCENT CHAMBERS. Lawrence W. Jones. 4p.

A brief summary is presented of the luminescent-chamber work at the Univ. of Michigan. A schematic diagram is presented of the first successful image-tube system. (W.L.H.)

**3635 UCRL-8706(p.46-8)**

Princeton Univ., N. J. Palmer Physical Lab.

COSMIC-RAY TRACKS IN FILAMENT SCINTILLATION CHAMBERS. George T. Reynolds, R. Giacconi, and D. Scarl. 3p.

A study was made to determine the operating characteristics of several Westinghouse and RCA image-tubes with P11 and P15 phosphors. Examples of cosmic-ray tracks made with filament scintillation chambers are given. (W.L.H.)

**3636 UCRL-8706(p.49-54)**

Centro Informazioni Studi Esperienze, Milan.

TIME SORTING OF MILLIMICROSECOND PULSES.

C. Cottini, E. Gatti, V. Svelto, and F. Vaghi. 6p.

Time sorting of millimicrosecond pulses, based on a vernier technique is discussed. Diagrams of circuits are presented for time sorting of millimicrosecond pulses. (W.L.H.)

**3637 UCRL-8706(p.55-8)**

National Bureau of Standards, Washington, D. C.

A TIME-DELAY-TO-AMPLITUDE CONVERTER. Zoltan Bay and F. McLernon. 4p.

The conversion of time delay to amplitude together with the use of a multichannel pulse-height sorter turns a coincidence circuit into a multichannel coincidence system. The theoretical advantages of such a system are discussed. In the experimental part a circuit is described which performs the pulse-height limiting of the input pulses by means of a grid-controlled secondary-electron emitter tube. Data concerning the sensitivity and time-resolution properties of the system are presented. (W.L.H.)

**3638 UCRL-8706(p.59-61)**

Oak Ridge National Lab., Tenn.

TIME-TO-PULSE-HEIGHT CONVERSION. John H. Neiler. 3p.

The application of time-to-pulse-height conversion is described. A circuit for a time-to-pulse-height apparatus is briefly described. (W.L.H.)

**3639 UCRL-8706(p.62)**

Oak Ridge National Lab., Tenn.

MANY COINCIDENCE CHANNELS. David M. Ritson. 1p.

The problem of hodoscoping a large array of counters in a machine experiment is briefly discussed. (W.L.H.)

**3640 UCRL-8706(p.63-7)**

Oak Ridge National Lab., Tenn.

MULTIDIMENSIONAL PULSE-MEASURING TECHNIQUES. Dan G. Maeder. 5p.

Two-dimensional coincidence methods are discussed for the determination of nuclear decay schemes. (W.L.H.)

**3641 UCRL-8706(p.68-70)**

Argonne National Lab., Lemont, Ill.

MEASUREMENTS OF MEAN LIFETIMES BETWEEN 10  $\mu$ sec AND LESS THAN 0.1  $\mu$ sec BY PULSED-BEAM TECHNIQUES. Frank J. Lynch and R. E. Holland. 3p.

Pulsed-beam experiments can be considered as the special class of delayed-coincidence measurements in which the initiating event is produced periodically. The apparatus described, was originally developed to measure neutron spectra by time of flight, it is also suitable for measurement of the lifetimes of excited states of nuclei. (W.L.H.)

**3642 UCRL-8706(p.71-5)**

Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.

MILLIMICROSECOND GAMMA-RAY DETECTOR AND OSCILLOSCOPE SYSTEM. Robert B. Patten. 5p.

With the advent of high-energy short-pulse radiation sources, there is a need for a high-resolution wide-dynamic-range detection and recording system. A single channel of a gamma-detection and -recording system which satisfies these requirements is discussed. The equipment is capable of resolving radiation rise times of less than 1  $\mu$ sec. A single channel has a dynamic range of 30,000 and a band width of about 1,000 Mc. (W.L.H.)

**3643 UCRL-8706(p.77-8)**

California. Univ., Berkeley. Lawrence Radiation Lab.

FAST-OSCILLOSCOPE REQUIREMENTS. Dick A. Mack. 2p.



Some of the desirable features and some of the objections of present high-time-resolution equipment are listed. (W.L.H.)

**3644** UCRL-8706(p.79-81)

California. Univ., Berkeley. Lawrence Radiation Lab. REQUIREMENTS ON FAST OSCILLOSCOPES. Quentin A. Kerns. 3p.

Switching between amplifier input and direct connection to CRT deflection plates in oscilloscopes is shown. (W.L.H.)

**3645** UCRL-8706(p.82-6)

Edgerton, Germeshausen and Grier, Inc., Boston. THE DESIGN OF A HIGH-SPEED CATHODE-RAY TUBE WITH A DISTRIBUTED DEFLECTION SYSTEM. Jacob Goldberg. 5p.

The electron optics and trajectories typical of an oscilloscope cathode-ray tube are shown. Two different cathode-ray tubes with distributed traveling-wave-type deflection systems are discussed. (W.L.H.)

**3646** UCRL-8706(p.87-8)

Tektronix, Inc., Portland, Oreg. DEVELOPMENT OF A VERTICAL-DEFLECTION AMPLIFIER FOR FAST OSCILLOSCOPES. John Kobbe. 2p.

The development of an amplifier for the vertical deflection of an oscilloscope in the region of  $\approx 5 \mu\text{sec}$  is discussed. (W.L.H.)

**3647** UCRL-8706(p.89-92)

Tektronix, Inc., Portland, Oreg. TYPE-519 OSCILLOSCOPE. Clifford Moulton. 4p.

Some of the triggering problems of the oscilloscope are discussed. (W.L.H.)

**3648** UCRL-8706(p.93-6)

Brookhaven National Lab., Upton, N. Y. FAST-RISE SAMPLING OSCILLOSCOPE AND PULSE GENERATOR. Robert M. Sugarman and F. C. Merritt. 4p.

A simple and inexpensive sampling oscilloscope and mercury-switch pulse generator are described whose combined step-function rise time is  $2.6 \times 10^{-10}$  sec. The oscilloscope will display a 30-millivolt signal with negligible noise, and has a band pass from zero to 2000 Mc. The pulse generator is used both as a source of strobe pulses for the scope and as a signal generator for the circuit under test. The instrument may be used to display any wave form, synchronous with the mercury-switch pulse source. (auth)

**3649** UCRL-8706(p.97)

Hewlett-Packard Co., Palo Alto, Calif. SAMPLING OSCILLOSCOPES. Norman B. Schrock. 1p.

The design of sampling oscilloscopes is briefly discussed. (W.L.H.)

**3650** UCRL-8706(p.98-104)

California. Univ., Berkeley. Lawrence Radiation Lab. PULSE GENERATORS. Quentin A. Kerns. 7p.

A light source is described for setting up and for monitoring the performance of phototubes in coincidence circuits. This source emits light when subjected to high-voltage pulses. The amplitude of the pulses is stable, the time jitter between the electrical pulses and the light pulse appears to be less than  $10^{-10}$  sec. Various types of pulse generators and component parts of pulse generators are discussed. (W.L.H.)

**3651** UCRL-8706(p.105-7)

California. Univ., Berkeley. Lawrence Radiation Lab. A MILLIMICROSECOND PULSE GENERATOR. Michiyuki Nakamura. 3p.

The design of a millimicrosecond pulse generator is described. Its output rise time is fast, less than  $2.5 \mu\text{sec}$ , and its maximum output level is 12 volts into 125 ohms. (W.L.H.)

**3652** UCRL-8706(p.109-12)

Michigan. Univ., Ann Arbor. MICROWAVE-GATED PHOTOMULTIPLIERS. Donald I. Meyer. 4p.

A discussion is presented on the improvement of photomultipliers to get higher time resolutions. The method suggested is to use a microwave field as a gate on a photomultiplier and do the timing measurements with the microwave signal. (W.L.H.)

**3653** UCRL-8706(p.113-17)

Stanford Univ., Calif. High-Energy Physics Lab. PULSE-HEIGHT ANALYSIS AND TIMING MEASUREMENTS OF FAST PULSES. Henry H. Kendall. 5p.

The circuits and equipment described were developed in connection with experiments using the electron beam from the Stanford high-energy electron accelerator. The detectors used are scintillation and Cherenkov. (W.L.H.)

**3654** UCRL-8706(p.118-19)

Princeton Univ., N. J. Palmer Physical Lab. SEMICONDUCTOR DEVICES IN COINCIDENCE CIRCUITS. Val L. Fitch. 2p.

The application of transistors to counting apparatus is discussed. (W.L.H.)

**3655** UCRL-8706(p.120-5)

Chicago. Univ. Enrico Fermi Inst. for Nuclear Studies. SIMPLIFIED COINCIDENCE CIRCUITS USING TRANSISTORS AND DIODES. Richard H. Miller. 6p.

The fast semiconductor diodes and transistors now available make it possible to design counting circuits that are as fast as standard fast vacuum tube circuits. A simple coincidence circuit using these devices is described. The measured threshold and resolving-time characteristics are given. The circuit is free from the difficulty present in some vacuum tube circuits wherein a coincidence count can be made with a pulse below the threshold at one input if a pulse considerably above the threshold is present at another input. The changes in counting arrangements which the simplicity of these circuits permits are discussed. With the appearance of fast diodes and transistors, which can be switched on or off in a few millimicroseconds, it becomes possible to build coincidence circuits which have resolution time and threshold properties similar to the conventional Garwin circuit, but which are much simpler to construct. This presentation describes tests made on some circuits of this type. (auth)

**3656** Y-1278

Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn. OPTIMIZING THE RATIO OF TIME CONSTANT TO RADIATION LEVEL FOR PRECISION COUNT-RATE METERS. A. H. Fowler and R. A. McLean. Apr. 27, 1959. 24p. Contract W-7405-eng-26. OTS.

When both accuracy and speed of response are required in the measurement of radiation level, a knowledge of the factors determining scatter is essential. In this report, a simple method of expressing the accuracy in terms of the integrating time and radiation level is developed. (auth)

**3657** AEC-tr-3916

NEW LIQUID SCINTILLATORS. Kh. V. Protopopov, Kh. A. Arslanov, S. V. Butomo, and T. V. Timofeeva (Timofeyeva). Translated by Lydia Venters (Argonne National Lab.) from *Priboiry i Tekh. Ekspt.*, No. 2, 24-8 (1958). 10p. JCL or LC.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 14459.

### 3658 JPRS-924-D

HANDBOOK OF APPARATUS USED IN DOSIMETRY, RADIMETRY AND ELECTRONICS, COUNTERS, SCINTILLATION APPARATUS AND PHOTOMULTIPLIERS. D. D. Uspenski (Uspenskiy), P. S. Savitski (Sovitskiy), V. I. Sinitsyn, and A. S. Shtan'. P.7-253 [of] Translation from *Spravochnik po Dozimetriceskim, Radiometriceskim i Elektronno-Fizicheskim Priboram, Schetchikam, Stsintilyatoram i Fotomnozhitel'yam*, 190p. OTS.

Descriptions of apparatus for individual dosimetry, alpha and beta radiation measurement, and radon contamination are presented. Also, amplifiers and discriminators, scalers and analyzers, regulated rectifiers, counters, and photomultipliers are described. The dimensions, purpose, and specifications of these apparatuses are given along with the price and ordering procedure. (J.R.D.)

### 3659 NP-tr-303

THEORY AND DESIGN OF AXIAL-FLOW AND CENTRIFUGAL COMPRESSORS. Yu. S. Podobuyev and K. P. Seleznev. Translated from p.1-392 of "Teoriya i Raschet Osevykh i Teentrobezhnykh Kompessorov." 631p. OTS.

A summary of information on the theory and design of axial-flow and centrifugal compressors is presented. Russian and other literature was surveyed and the methods employed in stationary and mobile turbocompressor machinery design are incorporated where possible. Examples illustrating design methods are included. 107 references. (J.R.D.)

### 3660

MEASUREMENT OF THE CIRCULAR POLARIZATION OF GAMMA RAYS BY DETECTION OF THE COMPTON ELECTRON: CRITICAL STUDY OF THE CLAY-HEREFORD EXPERIMENT. J. Deutsch. Ann. soc. sci. Bruxelles, Sér. II, 73, 270-8(1959). (In French)

The Clay-Hereford experiment (Phys. Rev. 85, 675 (1952)) on the measurement of the circular polarization of gamma rays by the detection of Compton electrons produced in magnetized Fe foils is analyzed critically. The failure of the experiment appears to be the result of insufficient magnetic orientation of the scatterer and detection of parasite gamma rays without interaction with the scatterer. The second difficulty is hard to eliminate, and it is concluded that Compton electron detection cannot be utilized for measurement of the circular polarization of gamma rays. (auth)

### 3661

A TIME-OF-FLIGHT SELECTOR FOR 14-Mev NEUTRONS. G. Deconninck and A. Martegani. Ann. soc. sci. Bruxelles, Sér. II, 73, 287-94(1959). (In French)

A time-of-flight neutron spectrometer for neutrons of 14 Mev energy from the  $T(d,n)He^4$  reaction was developed. With the "associated particle" method, a resolution of  $2 \times 10^{-9}$  sec was reached by means of the Green and Bell time-to-pulse-height converter circuit. (auth)

### 3662

SINGLE AND MULTI-CHANNEL PULSE HEIGHT ANALYZER. K. Fränz (Telefunken GmbH, Ulm/Donau, Ger.). Atompraxis 5, 381-7(1959) Oct.-Nov. (In German)

The properties of pulses generated by radiation detectors, in particular scintillation detectors with NaI (TI)-crystals for  $\gamma$  spectroscopy, are discussed as far as they are essential for pulse height analysis. The handling of such pulses by linear amplifiers and pulse lengtheners is treated. The main part of the paper deals with circuits for differential analyzers, gray-wedge spectroscopy, and

multichannel analyzers using time modulation and delay line and ferritecore techniques. (auth)

### 3663

COINCIDENCE-ANTICOINCIDENCE AND LINEAR GATE CIRCUITS. W. Klein (Firma Friesseke-Hoepfner GmbH., Erlangen-Bruck, Ger.). Atompraxis 5, 388-400(1959) Oct.-Nov. (In German)

Coincidence-anticoincidence installations are required for registering an event only if one or more other events occur simultaneously or non-simultaneously. The optimum coincidence-resolving capacity of an arrangement is dependent upon the input-pulse form and the amplitude range. Adjustment is best made via pulse-formers. The function of the actual coincidence-anticoincidence stages is usually based on one of three general circuit patterns: multiplicative mixture (Bothe circuit), additive mixture, possibly with bent characteristic lines (Rossi circuit), and bridge circuits. Examples of these three types of circuit are discussed. If an amplitude criterion is required in addition to the coincidence criterion, there are two general types of circuit: amplitude selection before coincidence selection and coincidence selection before amplitude selection. Examples of these types of circuit are also discussed. (auth)

### 3664

APPLICATION OF COINCIDENCE AND LINEAR GATE STAGES IN SCINTILLATION SPECTROMETRY. K. Jordan (Firma Friesseke-Hoepfner GmbH., Erlangen-Bruck, Ger.). Atompraxis 5, 401-7(1959) Oct.-Nov. (In German)

Some of the special scintillation spectrometers which are possible are described. In addition to the use of conventional coincidence circuits, the possibilities of linear gate stages are taken into consideration. The present results and those obtained previously are reported. (auth)

### 3665

NEUTRON DETECTORS. F. H. Rinn (Siemens and Halske A.G., Karlsruhe, Ger.). Atompraxis 5, 407-15(1959) Oct.-Nov. (In German)

The predominant part played by neutrons in nuclear physics and technology requires devices for measuring both intensity and energy distribution. Since neutrons cannot ionize, they are demonstrable only via nuclear reactions producing charged particles. Detectors for demonstrating thermal neutrons utilize the large effective cross-section of the isotopes  $B^{10}$  and  $Li^6$  for the  $(n,\alpha)$  reaction. Tubes filled with  $BF_3$  are used as counters; since these are proportional counters, they provide good discrimination against  $\gamma$  quanta. For higher neutron fluxes, neutron chambers with boron-coated electrodes are used. A careful choice of chamber materials keeps self-activity and the resultant falsification of the measurement result at a low level. An extension of the measurement range to lower neutron fluxes is possible by using compensated neutron chambers which eliminate the chamber current from  $\gamma$  radiation. Thermocolumns have proved useful for measuring high neutron fluxes. Neutron scintillation-counters have certain advantages over  $BF_3$  counters: the  $\alpha$ -particles from  $(n,\alpha)$  reactions as well as the  $\gamma$  quanta from  $(n,\alpha)$  reactions can be used for neutron demonstration. Fast neutrons can also be detected with these detectors if they have previously been decelerated to thermal velocity by suitable moderators. Counter tubes and scintillation counters are suitable for measuring intensity and energy if the fast neutrons are allowed to produce ionizing recoil nuclei by elastic collision. Here the problem of  $\gamma$  discrimination is rather difficult, but a marked reduction of  $\gamma$  sensitivity can be attained by registering anticoincidences



and delayed coincidences, or by utilizing the different scintillation-time constants for different exciting particles. Nuclear reactions with a reaction threshold value are also suitable for neutron measurement. There are no good measurement methods for neutrons in the moderately fast range; thus at present they are undetectable. (auth)

### 3666

NUCLEAR POWER STATION CONTROLS. S. A. Lacey (General Radiological Ltd., London). *Atompraxis* 5, 416-19(1959) Oct.-Nov.

The control of nuclear power stations involves far more complicated measurement systems than are normally installed in conventional power stations. Coal or oil fired boiler systems require the power output to be measured over at most two decades. Nuclear power stations require monitoring of reactor parameters over as many as eleven decades. The basic additional measurements to be made are of temperature and neutron flux within the reactor and further monitoring to detect any burst fuel elements. This additional quantity of electronic measuring apparatus is designed with emphasis on reliability and "failure to safety"; even so, the station control staff uses special equipment which conveys to them a reliable analysis of normal operating conditions and which, in the event of an alarm, automatically distinguishes between a reactor defect and a fault in one of the many measuring channels. (auth)

### 3667

CONTINUOUS DIRECT MONITORING OF LOW  $\beta$  ACTIVITIES IN WATER. H. Kiefer and R. Maushart (Kernreaktor Bau- und Betriebs-GmbH., Karlsruhe, Ger.). *Atompraxis* 5, 431-3(1959) Oct.-Nov. (In German)

A description of an installation for the continual direct control of  $\beta$  activity in water is given. The unit functions by means of two large-area methane flowthrough counters, one of which is screened against  $\beta$  radiation. The indicators are connected in difference in order to suppress the zero effect. As the counters are situated above the water level they cannot become contaminated. The sensitivity of the unit is sufficient to register the maximum permissible concentration of all dangerous  $\beta$  radiators. The use of such a unit for air control is discussed. (auth)

### 3668

SCINTILLATION  $\alpha$  SPECTROSCOPY. Francesca Demichelis. *Atti acad. nazl. Lincei Rend., Classe sci. fis., mat. e nat.* 26, 221-4(1959) Feb. (In Italian)

In order to obtain the best time and energy resolution possible for alpha radiation, three types of scintillators were investigated with respect to their resolution properties. The scintillators studied were CsI(Tl), two anthracene crystals, and two plastic scintillators of terphenyl and tetraphenyl butadiene in polystyrene. The results showed that CsI(Tl) has the best energy resolution, but it has a long decay time. Anthracene has a better decay time, but poorer energy resolution. The plastic scintillators had the best decay time, and the lowest energy resolution. (J.S.R.)

### 3669

THE MAGNETRON GAUGE: A COLD-CATHODE VACUUM GAUGE. P. A. Redhead (National Research Council, Ottawa). *Can. J. Phys.* 37, 1260-71(1959) Nov.

A cold-cathode ionization gage with axial magnetic field is described which is capable of measuring pressure in the range  $10^{-3}$  to  $10^{-12}$  mm Hg, and is primarily useful in the range above  $5 \times 10^{-10}$  mm Hg. The gage is operated with an anode voltage of 6 kilovolts and a magnetic field of 1000 gauss. The relationship between ion current and pressure is linear in the pressure range  $10^{-4}$  to  $5 \times 10^{-10}$  mm Hg; at

lower pressures the relationship  $i_p = cP^{1.7}$  holds. In the linear region the ion current per unit pressure is given by  $i_p$  (amperes) =  $9P$  (mm Hg) for nitrogen (i.e., a sensitivity about 45 times greater than obtainable with a thermionic triode gage). (auth)

### 3670

PRINCIPLE OF THE ANALYSIS OF COMPOUND EXPERIMENTAL CURVES: APPLICATION TO THE MEASUREMENT OF THE GRAIN DENSITY IN STRONGLY IONIZED TRACKS IN NUCLEAR EMULSIONS. W. Paskevici (Université, Montreal). *Can. J. Phys.* 37, 1314-20(1959) Nov. (In French)

The principle of a mathematical method using Fourier transforms, which makes possible the decomposition of a complex experimental curve formed by the superposition of several curves having the same analytical form but different amplitudes, is described. The possibility of using this analysis to determine, from photometric curves, the grain density of tracks made by strongly ionizing particles in ionographic emulsions is considered in particular. The utilization and precision of the method is shown by a simple idealized example. (tr-auth)

### 3671

FILM DOSIMETRY OF  $\gamma$  RADIATION WITH THE AID OF A PROTECTED CALIBRATION APPARATUS. Valerija Palić (Université, Zagreb and Institut "Ruder Boskovic," Zagreb). *Compt. rend.* 249, 1951-3(1959) Nov. 9. (In French)

### 3672

FAST COINCIDENCES WITH SLOW SCINTILLATORS. F. T. Arecchi (CISE, Milan). *Energia nucleare (Milan)* 6, 717-26(1959) Nov.

Two different methods for working with the output pulses from a slow scintillation counter are described. These methods were introduced in order to achieve a good time resolution in time measurements. Two devices were designed and their technical features are discussed here. The experimental results are compared with the theoretical calculations. (auth)

### 3673

A DIAGNOSTIC X-RAY EXPOSURE DOSE CHAMBER. R. Garrett and J. S. Laughlin (Memorial Hospital and Sloan-Kettering Inst., New York). *Health Phys.* 2, 189-94(1959) Oct.

The design of a miniature condenser ionization chamber for the measurement of diagnostic x-ray exposure dose is described. Response relative to the roentgen as a function of energy for x-rays with a range of half value layers from 0.2 to 5.0 mm Al (effective energies of 12.8 and 41.5 kev, respectively) is kept constant by the correct choice of chamber dimensions and by constructing the chamber entirely of material of lower atomic number than that of air. Measured values of sensitivity and directional dependence are presented together with the calculated maximum dose rate. The chambers can be made in large numbers by a molding technique with completely reproducible properties. (auth)

### 3674

CHARACTERISTIC CURVES FROM DIFFERENT IONIZING RADIATIONS AND THEIR SIGNIFICANCE IN PHOTOGRAPHIC DOSIMETRY. R. Golden and E. Tochilin (U. S. Naval Radiological Defense Lab., San Francisco). *Health Phys.* 2, 199-206(1959) Oct.

Characteristic curves for six different emulsions were obtained with nuclear radiations of a wide range of specific ionization. Sources included  $\alpha$ -particles, protons, neutrons, and  $\beta$ ,  $\gamma$ , and x rays. The two most sensitive films

(Eastman Type K and Dupont Type 555) exhibited characteristic curves identical in shape for all exposures. Curves for the remaining films were found to be dependent on the type of radiation. When log density was plotted against log exposure, the curves fell into two groups. For particles with specific ionization equal to or greater than that produced by 30 kev x rays, the slope in the linear region approached 1.0. For high-energy  $\beta$  rays,  $\gamma$  rays, and electrons, slopes greater than 1.0 were obtained. In most cases identical saturation densities were observed. Data are presented which show that  $\gamma$ -ray characteristic curves can be simulated with  $\beta$  rays. This technique can considerably simplify exposure procedures, particularly where high-level exposures are involved. (auth)

### 3675

A FILM TECHNIQUE FOR MEASURING THE EXPOSURE DOSE FROM PLUTONIUM. E. C. Watson (General Electric Co., Richland, Wash.). Health Phys. 2, 207-12(1959) Oct.

The electromagnetic radiations from plutonium are considered in three effective energy groups; x-rays of 17 kev,  $\gamma$ -rays of 60 kev, and  $\gamma$ -rays of energies greater than 400 kev. The low penetrating power of the x-rays is demonstrated, using a water phantom. Because of the ease with which they are absorbed, the testes are considered the critical organ. The measurement of all three energy groups with monitoring film is complicated by the energy dependence of the photographic emulsion used. The energy dependence of DuPont Type 502 emulsion is shown to peak in sensitivity at about 45 kev. The effect of shielding the film, as in a film badge, improves the energy dependence but limits the minimum energy which can be measured to about 60 kev. The shielding features in the Hanford Film Badge permit measurement of the exposure dose of the three energy groups. From a set of generalized equations relating exposure dose and net density, expressions are derived for the dose due to each energy group. (auth)

### 3676

A FISSION GAS MONITOR FOR GAS COOLED OR OFF-GAS EXPERIMENTAL SYSTEMS. J. F. Sommers and I. J. Wells (Phillips Petroleum Co., Idaho Falls, Idaho). Health Phys. 2, 213-15(1959) Oct.

The fission gas monitor is a very sensitive instrument for the detection of fresh fission products in gas cooled or off-gas systems. It is quite versatile so that it can be used on a wide variety of experiments either as a quick, positive, and sensitive detector of fission products or as a quantitative measuring device for release of fresh gaseous fission products. Installation costs are reasonable. The formula presented for quantitative analyses is adequate for constant production rates of fission gases where the delay time between filters  $F_1$  and  $F_2$  is not much greater than the half life of the daughter product to be collected and analyzed on the  $F_2$  filter. Examples of data obtained with a prototype monitor and curves illustrating calculated sensitivity of the monitor indicate the usefulness of the system for monitoring gas streams containing fresh fission gases and also illustrate a few of the many methods of making quantitative analyses to determine production rates of fission products in gas effluent lines. (auth)

### 3677

MAGNETIC  $\alpha$  SPECTROMETER. B. S. Dzhelepov, R. B. Ivanov, V. G. Nedovesov, and V. G. Chumin (Khlopin Radium Inst., Academy of Sciences, USSR). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz. 23, 782-7(1959) July. (In Russian)

The construction and operation of a magnetic  $\alpha$  spectrom-

eter with resolving power  $\Delta H_p/H_p \sim 0.10\%$  and light power order of  $\sim 0.3\%$  from  $4\pi$  are described. (R.V.J.)

### 3678

A LARGE MULTIPLATE CLOUD CHAMBER FOR COSMIC RAY OBSERVATION. Saburo Miyake, Kensaku Hinotani, Itsuo Katsumata, and Tatsunosuke Kaneko (Osaka City Univ.). J. Phys. Soc. Japan 14, 1471-4(1959) Nov.

A large multiplate cloud chamber was constructed for the observation of the extensive air showers by extremely high energy cosmic radiations. Its dimensions of sensitive volume are 200 cm wide, 130 cm high, and 90 cm deep. It contains 21 sheets of lead plate of 1 cm thick, so that the total thickness of the absorber corresponds to about 48 radiation length or about three times of nuclear interaction mean free path. The design and operational character are reported. (auth)

### 3679

A PROPOSED INSTRUMENT FOR RADIOMETRIC MEASUREMENTS. L. A. Sarkes, N. L. MacKinnon, R. I. Buckley, and H. J. Boulanger (M & C Nuclear, Inc., Attleboro, Mass.). Nondestructive Testing 17, 351-3(1959) Nov.-Dec.

The operation and application of a scintillation gamma spectrometer for inspecting nuclear reactor fuel elements for uranium distribution and enrichment are described. (J.E.D.)

### 3680

INSTRUMENT DEVELOPMENT AT SAVANNAH RIVER LABORATORY. III. HEALTH PHYSICS, LABORATORY INSTRUMENTS. J. N. Wilson (E. I. du Pont de Nemours & Co., Aiken, S. C.). Nucleonics 17, No. 12, 86; 88; 90; 92-4; 96(1959) Dec.

The application and construction features of the following instruments are discussed: spark-counter detectors, scintillation monitors, air impactors, long probes, cold-cathode circuits, and tritium surface monitors. An ultrasonic delay line and a photomultiplier tester are described. (C.J.G.)

### 3681

THE BASIC DESIGN DATA OF A GUARDED-FIELD THIMBLE IONIZATION CHAMBER: A THEORETICAL INVESTIGATION. Barry Barber (London Hospital Research Labs.). Phys. in Med. Biol. 4, 1-9(1959) July.

A mathematical investigation of the electrostatic field configuration inside a guarded-field ionization chamber is described. The basic design data for this type of chamber are derived and shown to be in good agreement with the previously obtained experimental design data. Also, the theory provides an extension of the experimental data where, on the one hand the collecting electrode is vanishingly small and on the other hand, where the ratio of the collecting electrode radius to the internal radius of the chamber approaches unity. (auth)

### 3682

MINIATURE IONIZATION CHAMBERS FOR MEASUREMENTS IN BODY CAVITIES. S. Benner, I. Ragnhult, and G. Gebert (Univ. of Göteborg). Phys. in Med. Biol. 4, 26-7(1959) Nov.

The construction of miniature ionization chambers is described and an instance of their use is given. (auth)

### 3683

A SIMPLE CIRCUIT FOR SIMULTANEOUS DOSE-RATE AND DOSE MEASUREMENTS. Sven Benner (Univ. of Göteborg). Phys. in Med. Biol. 4, 28-9(1959) July.

A simple accessory is described for measuring the integrated dose in an irradiation at varying dose-rate, which has to be read or recorded during the irradiation. (auth)



**3684**

A NOTE ON THE CALIBRATION OF X-RAY DOSEME-TERS. John Tooze and Boyce Worthley (Univ. of Adelaide). *Phys. in Med. Biol.* **4**, 30-2(1959) July.

A method is given for the rapid quality calibration of x-ray dosimeters based upon the use of a charge comparator and the measurement of electrometer charge sensitivity using a  $\text{Sr}^{90}$  plaque. (auth)

**3685**

THE STOPPING-POWER CORRECTION FOR GRAPHITE CAVITY-CHAMBERS USED WITH 2 mV X-RAYS. G. P. Barnard and A. R. S. Marsh (National Physical Lab., Teddington, Middx, Eng.). *Phys. in Med. Biol.* **4**, 33-42 (1959) July.

A precise comparison has been made of the relative behavior of a typical graphite cavity ionization chamber and an identical chamber made from an alloy of lithium and magnesium (average number of electrons per atom, 8.244). An examination has been made of the difficulties involved in determining precisely a stopping-power correction for the NPL graphite cavity ionization chambers in view of the existing uncertainties in the present state of knowledge. It is concluded that the present arbitrary total correction of +3% applied to the readings of the graphite chambers for wall absorption, lack of electronic equilibrium and stopping power cannot be seriously in error. (auth)

**3686**

THE RESPONSE OF PLASTIC SCINTILLATORS TO PROTONS. H. C. Evans and E. H. Bellamy (Univ. of Glasgow). *Proc. Phys. Soc. (London)* **74**, 483-5(1959) Oct. 1.

Plastic scintillators were found to obey the formula  $(dS/dr) = (A dE/dr)/(1 + kB dE/dr)$  quite accurately. An NE.102 type plastic scintillator, 2 in. in diameter and  $\frac{1}{2}$  in. thick, was used. The values obtained for the constant kB were found to agree quite well with values of kB obtained by Borell and Grimeland. (C.J.G.)

**3687**

TECHNIQUE DEVELOPMENTS IN GAMMA SPECTROMETRY BY SCINTILLATION COUNTERS. Cl. Brooke (Université Libre, Brussels). *Rev. M.B.L.E.* **2**, 285-317(1959) Oct. (In French)

The possibility of applying the technique of scintillation spectrometry to the measurement of gamma radiations of very high and very low energies, to the determination of the relative intensities of electromagnetic transitions, and to the analysis of mixtures of short-lived radionuclides is shown. The sum-coincidence method of A. Hoogenboom is examined and explained. (tr-auth)

**3688**

DEPENDENCE OF THE DECAY TIME OF SCINTILLATORS ON THE SPECIFIC IONIZATION OF THE PARTICLES AND ITS APPLICATION. Mario Forte (Comitato Nazionale Ricerche Nucleari, Ispra, Italy). *Studia Ghisleriana Ser. IV*, **2**, 281-305(1959). (In Italian)

In some types of scintillators, the ionization density produced by the exciting particle influences the scintillation efficiency and the time variation of fluorescent intensity. This last property affords a new criterium for the discrimination scintillation pulses caused by different types of particles. In the case of organic scintillators, in addition to the fast initial decay, slow ( $\sim 10^{-7}$  sec) components of the scintillation were found which are proportionally larger for particles with higher specific ionization. These properties can be interpreted in terms of slow recombination of ions in the scintillator and of quenching processes, whose influence changes during the subsequent stages of the scintillation. The methods used for the selec-

tion between such pulse shapes are described, and experimental results showing such effects in the scintillations excited by electrons and recoil protons in anthracene, stilbene, and activated liquids and plastics are discussed. Counters were made that can discriminate the scintillations of fast neutrons in presence of  $\gamma$  fluxes of much higher intensities, irrespective of the pulse amplitudes. In the case of some inorganic scintillators, like NaI(Tl) and CsI(Tl), the scintillation decay time is fundamentally one, but details of the pulse shapes are different for particles of different specific ionization. A method is considered that is useful, in this case, in obtaining quantitative information corresponding to the pulse shape (i.e. to the particle type), and preliminary results with electron and proton scintillations in NaI(Tl) are described. (auth)

**3689**

THE EMPLOYMENT OF A PHOTOGRAPHIC FILM FOR INDIVIDUAL DOSIMETRIC CONTROL OF THE  $\beta$ -PARTICLES FLUX. N. S. Nikitin. *Vestnik Rentgenol. i Radiol.* **34**, No. 4, 59-65(1959) July-Aug. (In Russian)

The possibility of employment of a photographic film for  $\beta$ -dosimetry is discussed. A methodical procedure is suggested for conducting individual control of the  $\beta$ -particles flux with the aid of a recommended cassette. The control of the  $\beta$ -particle flux may be carried out in presence of  $\gamma$  radiation, the physical dose of which is determined by the darkening of the same film. The graduated dependence curve of film darkening on radiation dose is traced in the same way as in conducting the individual photo-control of  $\gamma$  effects.  $\text{Co}^{60}$  or radium are used as a source of radiation. The relative sensitivity of the film to  $\beta$ -radiation for thin and thick flat  $\beta$ -radiators is characterized by the B coefficient, the value of which is given in the table. The practical use of the photo-film as a  $\beta$ - and  $\gamma$ -dosimeter for a wide range of energies is possible when the spectrum of the  $\beta$ -radiation is known and that  $\beta$  radiation is not accompanied by a significant amount of  $\gamma$  radiation with the energy below 200 Kev. (tr-auth)

**3690**

INDICATORS OF GAMMA-RADIATION EQUIPPED WITH PHOTO-RESISTANCE. Yu. S. Deev, A. N. Krongauz, and R. S. Milstein (State Scientific-Research Inst. of Roentgen-Radiology, Ministry of Health, RSFSR). *Vestnik Rentgenol. i Radiol.* **34**, No. 4, 66-8(1959) July-Aug. (In Russian)

Descriptions are given of the design and performance of  $\gamma$  radiation dosimeter equipped with a photoresistance. (R.V.J.)

**3691**

AN APPARATUS FOR MEASURING RADIOACTIVE ISOTOPE SOLUTIONS. A. Ya. Gelfman and V. V. Vasyurenko (Khar'kov Inst. of Medical Radiology). *Vestnik Rentgenol. i Radiol.* **34**, No. 4, 68-9(1959) July-Aug. (In Russian)

The design and performance of an apparatus for measuring radioactive isotope solutions are described. (R.V.J.)

## Materials Testing

**3692** AECU-4484

Franklin Inst. Labs. for Research and Development, Philadelphia.

STABILITY OF EXTERNALLY PRESSURIZED GAS JOURNAL BEARINGS. Interim Report. Lazar Licht. Oct. 1959. 36p. Sponsored by Dept. of Defense; AEC; and Maritime Administration under Contract Nonr-2342(00). (I-A2049-8). OTS.

A stability analysis is developed for gas journal bear-

ings having externally pressurized pads, symmetrically spaced along the circumference. Simplifying assumptions are made and equations of flow and motion are stated in terms of perturbation quantities. The case considered is when the journal, initially in an eccentric equilibrium position, begins to move in an arbitrary direction under the influences of a small, random disturbance. Methods of factorizing and simplifying the characteristic determinants are shown, with the objective of reducing the work of examining the roots of characteristic equations. Special cases, such as the bidirectional thrust bearing and that of the journal initially in concentric position are discussed. Numerical and semi-experimental procedures of determining the coefficients of characteristic equations are outlined. Stability tests are suggested. A simple numerical example is included. Bearing parameters affecting stability are discussed. (auth)

**3693** MSAR-59-130  
MSA Research Corp., Callery, Penna.  
BTF PRESSURIZER BLOWDOWN TEST. Technical Report 69. G. E. Kennedy and V. K. Heckel. Nov. 27, 1959. 117p. Contract NObs-77023.

The purpose of this test was to obtain pressure vessel blowdown data to establish that the specific application of the mathematical model used to describe the reactor blown down is conservative. Thirty-six runs were made encompassing three variables: temperature (600, 500, 400°F); orifice size (3.75, 3, 2, 1.5, 1, 0.2 in.); and position (top or bottom discharge). In addition, six reruns were made to check the reproducibility of the data. The results are given, but no conclusion or recommendations are given. (auth)

**3694**  
THE USE OF  $\alpha$ -INDUCED RADIOACTIVITY FOR A QUANTITATIVE CONTROL OF PRODUCTS CONTAINING ALUMINIUM AND BORON. I. N. Plaksin, V. M. Smirnov, and L. P. Starchik. *Doklady Akad. Nauk S.S.S.R.* **128**, 1208-9 (1959) Oct. 21, (In Russian)

Alpha induced artificial radioactivity has been used in biological analysis of tissues. A method using  $\text{Po}^{210}$   $\alpha$  radiation is suggested for fast analysis of powdered specimens of Al- and B-containing ore. (R.V.J.)

## GEOLOGY, MINERALOGY, AND METEOROLOGY

**3695** RME-3160  
Massachusetts Inst. of Tech., Cambridge.  
INDUCED POLARIZATION: A STUDY OF ITS CAUSES AND MAGNITUDES IN GEOLOGIC MATERIALS. Final Report. Theodore R. Madden and Donald J. Marshall. June 1959. 78p. Contract AT(05-1)-718. OTS.

The causes of induced electrical polarization include not only the polarization of metal-solution interfaces, but also effects associated with the coupling of different flows. Electro-osmotic, thermal electric, and ion diffusion effects are among such examples. A study of the physical properties of geologic materials indicates that only electrode interface and diffusion flow phenomenon are important sources of induced polarization effects. At higher frequencies electro-magnetic coupling effects interfere with the induced polarization measurements. Simple theoretical models for the polarizing effect of metallic minerals or membrane zones within a rock give reasonable results when the influence of surface conductivity is taken into ac-

count. The nature of the polarizing mechanisms, and the geometric complications existing in natural samples can make it very difficult to distinguish between the two polarizing mechanisms from electrical measurements only. Rather simple magnitude criteria present the best means of accomplishing such a distinction. The effects of well mineralized sulfide zones are easily recognized, but the background effects possible from membrane polarization are capable of masking certain mineral targets. (auth)

**3696** YAEC-RD-4  
Yankee Atomic Electric Co., Boston.  
DIFFUSION IN A DEEP RIVER VALLEY. James M. Austin and John W. Lebourveau. Nov. 16, 1959. 14p. OTS.

A study was made of atmospheric diffusion in valleys. Data are presented from a series of observations made in the valley of the Deerfield River. The river meanders through hilly regions of western Massachusetts and southern Vermont. The site selected was about 1,150 ft above sea level with hills on both sides within a horizontal distance of one mile rising to an elevation of 2,000 ft. The valley is densely wooded on both sides. Data on air circulation in the valley are presented. (C.H.)

**3697** NP-tr-319  
CONTRIBUTIONS TOWARDS THE ESTABLISHMENT OF A METHOD FOR THE CALCULATION OF THE CAPACITY OF GRINDING MACHINERY. I. Huber Panu and Emil Popa. Translated from *Acad. rep. populare Romîne, cercetări met.* **2**, 499-522(1957). 30p. (Figures omitted). JCL.

A method is established for the calculation of the output capacity of various ore grinding equipment. (W.L.H.)

**3698**  
THE NATURAL OCCURRENCE OF GALENA-CLAUSTHALITE SOLID SOLUTION SERIES. Robert G. Coleman (Geological Survey, Menlo Park, Calif.). *Am. Mineralogist* **44**, 166-75(1959) Jan.-Feb.

A study of the sulfides associated with the vanadium-uranium deposits of the Colorado Plateau revealed that a complete natural solid solution series exists between galena (PbS) and clausthalite (PbSe). Twenty analyzed samples range in composition from 0.04 to 93.7 molecular per cent PbSe in PbS with a concomitant variation of the unit cell from 5.930 Å to 6.127 Å. A plot of these values using the  $a_0 = 5.936$  Å for PbS and  $a_0 = 6.140$  Å for PbSe indicates an almost straight line variation of the cell edge between galena and clausthalite. Mineragraphic and x-ray study shows these minerals to be true solid-solution phases; exsolution of one end member in the other was not found. Semiquantitative spectrographic analyses indicate that the minor elements in these sulfides are similar to those found in galena with some variations resulting from the environment of deposition. (auth)

**3699**  
APPLICATION TO THE MEASUREMENT OF WEAK THERMOLUMINESCENCE IN GEOLOGY AND MINERALOGY. F. G. Houtermans (Universität, Bern). p.9-12 of "Atti del I<sup>o</sup> Convegno di Geologia Nucleare Tenuto in Roma il 4 Aprile 1955. (Acta of the 1st Congress of Nuclear Geology held in Rome, April 4, 1955)." Rome, Comitato Nazionale per le Ricerche Nucleari, 1955. 62p.

Research at Bern University in radioinduced thermoluminescence of meteoritic material, volcanic tuff, and other minerals is briefly described. (T.R.H.)

**3700**  
MINOR CONSTITUENTS OF ITALIAN RADIOACTIVE MINERALS. C. Garavelli and F. Tonani (Univ. of Florence). p.13-16 of "Atti del I<sup>o</sup> Convegno di Geologia Nucleare



Tenuto in Roma il 4 Aprile 1955. (Acta of the 1st Congress of Nuclear Geology held in Rome, April 4, 1955)." Rome, Comitato Nazionale per le Ricerche Nucleari, 1955. 62p.

A spectrographic study was made of U minerals and associated materials from the island of Montecristo, and from Lurisia di Mondovì. Three sulfide samples and one sample of crystalline zeunerite were examined. The fundamental sulfide constituents are, in order: Cu, Co, Ni, Bi, Ag, Sn, Pb, V, and Zn. The three sulfide samples contained ~1% Cu, ~0.2% Co, 0.01% Ni, and ~0.01% Mn. In the zeunerite of Montecristo were found As, Cu, U, Fe, Co, Ni, Zn, and probably Bi. (T.R.H.)

### 3701

RADIOACTIVE MINERALS OF SANDS OF THE LAZIAL SHORES. S. Bonatti (Università, Pisa). p.17-21 of "Atti del I<sup>o</sup> Convegno di Geologia Nucleare Tenuto in Roma il 4 Aprile 1955. (Acta of the 1st Congress of Nuclear Geology held in Rome, April 4, 1955)." Rome, Comitato Nazionale per le Ricerche Nucleari, 1955. 62p.

The areas studied are pointed out; they extend from Palo to Lido di Lavinia and to the Garigliano River. The radioactive minerals found are: thorite, monazite, ortite, and perrierite. Perrierite is a new mineralogical species similar to chevkinite. It is a silicotitanate, formula  $\text{Ce}_2\text{O}_3 \cdot 2\text{TiO}_2 \cdot 2\text{SiO}_2$ , containing 4% Th. (T.R.H.)

### 3702

GEOCHEMISTRY OF THE ISOTOPES IN METEORIC WATER AND OF THERMAL ORIGIN. G. Boato (Università, Geneva); and H. Craig (Univ. of Chicago). p.22-9 of "Atti del I<sup>o</sup> Convegno di Geologia Nucleare Tenuto in Roma il 4 Aprile 1955. (Acta of the 1st Congress of Nuclear Geology held in Rome, April 4, 1955)." Rome, Comitato Nazionale per le Ricerche Nucleari, 1955. 62p.

Preliminary data are given on isotopic composition of meteoric and thermal water, and consideration is given to the nature of the condensation and evaporation processes at the surface of the earth. (T.R.H.)

### 3703

THE NATURAL RADIOACTIVITY OF LAVA FROM LAZIAL VOLCANOES AND PHOSPHATIC ROCKS FROM SALENTO. V. Caglioti, C. Bettinali, and F. L. Salvetti (Consiglio Nazionale delle Ricerche, Rome). p.36-41 of "Atti del I<sup>o</sup> Convegno di Geologia Nucleare Tenuto in Roma il 4 Aprile 1955. (Acta of the 1st Congress of Nuclear Geology held in Rome, April 4, 1955)." Rome, Comitato Nazionale per le Ricerche Nucleari, 1955. 62p.

Preliminary results are given from a study to define the real nature of the radioactivity of lava from Lazial volcanoes and phosphate rock from Salento. Polarographic, fluorometric, and radiometric methods were used. (T.R.H.)

### 3704

RADIOACTIVE CONTENT OF BITUMINOUS LIMESTONE OF RAGUSA. A. Bellanca, M. Curatolo, and M. Santangelo (Università, Palermo, Italy). p.42-5 of "Atti del I<sup>o</sup> Convegno di Geologia Nucleare Tenuto in Roma il 4 Aprile 1955. (Acta of the 1st Congress of Nuclear Geology held in Rome, April 4, 1955)." Rome, Comitato Nazionale per le Ricerche Nucleari, 1955. 62p.

The specific alpha activities and bitumen contents of 8 samples of limestone from Ragusa were determined. A correlation between these two values is sought. The U and Th content were determined from  $\alpha$  activity by Houtermans' method. Indicative results were obtained. (T.R.H.)

### 3705

RADIOACTIVITY OF VESUVIAN LAVA. M. De Martino (Università, Naples). p.46 of "Atti del I<sup>o</sup> Convegno di

Geologia Nucleare Tenuto in Roma il 4 Aprile 1955. (Acta of the 1st Congress of Nuclear Geology held in Rome, April 4, 1955)." Rome, Comitato Nazionale per le Ricerche Nucleari, 1955. 62p.

Measurements of 10 samples of Vesuvian lava confirm previous results which showed that the Th content remains almost constant while the U content decreases noticeably with age. (T.R.H.)

### 3706

RADIOMETRIC STUDY OF THE LARGE CONE OF VESUVIUS. G. Imbò (Università, Naples). p.47 of "Atti del I<sup>o</sup> Convegno di Geologia Nucleare Tenuto in Roma il 4 Aprile 1955. (Acta of the 1st Congress of Nuclear Geology held in Rome, April 4, 1955)." Rome, Comitato Nazionale per le Ricerche Nucleari, 1955. 62p.

The qualitative observation is made that the gamma activity of tuff, sand, detritus, and lava is increasing. (T.R.H.)

### 3707

DISTRIBUTION OF RADIOACTIVITY IN THE GRANODIORITIC FACIES OF ADAMELLO. O. Hieke Merlin (Università, Padua); and E. Picciotto and S. Wilgain (Université libre, of Brussels). p.48-9 of "Atti del I<sup>o</sup> Convegno di Geologia Nucleare Tenuto in Roma il 4 Aprile 1955. (Acta of the 1st Congress of Nuclear Geology held in Rome, April 4, 1955)." Rome, Comitato Nazionale per le Ricerche Nucleari, 1955. 62p.

The distribution of natural  $\alpha$  emitters in samples of granodiorite from the Adamello group was studied by a photographic method. Thin sections were radiographed and studied mineralogically. The  $\alpha$  activity was very heterogeneously distributed, most of the U and Th being concentrated in the accessory minerals. (T.R.H.)

### 3708

VOLCANIC LEAD OF VESUVIUS AND THE VOLCANO. P. Eberhardt, J. Geiss, F. G. Houtermans, W. Buser, H. R. Von Gunten (Universität, Bern). p.50-6 of "Atti del I<sup>o</sup> Convegno di Geologia Nucleare Tenuto in Roma il 4 Aprile 1955. (Acta of the 1st Congress of Nuclear Geology held in Rome, April 4, 1955)." Rome, Comitato Nazionale per le Ricerche Nucleari, 1955. 62p.

Results of activity and isotopic content measurements are given for RaD in columbite, galena, and cannizzarite samples from Vesuvius, dating back to 1825. These results are compared and discussed with respect to geological age. (T.R.H.)

### 3709

DEPENDENCE OF RADIOACTIVITY OF VESUVIAN LAVA ON DATE OF ERUPTION. M. Ferretti-Sforzini (Università, Rome); C. Festa (Istituto Nazionale di Geofisica, Rome); and F. Ippolito (Comitato Nazionale Ricerche Nucleari, Rome). p.57-62 of "Atti del I<sup>o</sup> Convegno di Geologia Nucleare Tenuto in Roma il 4 Aprile 1955. (Acta of the 1st Congress of Nuclear Geology held in Rome, April 4, 1955)." Rome, Comitato Nazionale per le Ricerche Nucleari, 1955. 62p.

Three tabulations of data on U content of lava samples from various locations and various eruptions of Vesuvius are presented and discussed. (T.R.H.)

## HEALTH AND SAFETY INCLUDING DOSIMETRY

### 3710 AFSWP-611

Armed Forces Special Weapons Project, Washington, D. C. MILITARY ASPECTS OF THE BIOLOGICAL EFFECTS OF

RADIATION. Nathaniel I. Berlin. Nov. 9, 1956. 55p.

Mammalian radiobiology is reviewed as it is applicable to man from the standpoint of military applications. The primary sources of the information summarized include the Atomic Bomb Casualty Commission evaluation of results of Hiroshima and Nagasaki, evaluation of results of the accidental exposure of the Marshallese during Operation Castle, accidents in Atomic Energy laboratories, and clinical radio-therapeutic experiences. (C.H.)

**3711** SUI-59-7

Iowa. State Univ., Iowa City.

ON THE RADIATION HAZARDS OF SPACE FLIGHT.

James A. Van Allen. May 1959. 31p.

An appraisal of the radiation hazard of space flight is presented. Included are considerations of cosmic rays, auroral soft radiation, the geomagnetically-trapped corpuscular radiation, and the nature and origin of trapped radiation. In addition, radiation exposure levels and practical space flight considerations are discussed. (J.R.D.)

**3712**

ACCIDENTAL RADIATION EXCURSION AT THE OAK RIDGE Y-12 PLANT. III. DETERMINATION OF RADIATION DOSES. G. S. Hurst, R. H. Ritchie, and L. C. Emerson (Oak Ridge National Lab., Tenn.). *Health Phys.* **2**, 121-33(1959) Oct.

The methods used to arrive at the doses received by individuals are described. The doses were determined by the following procedure. Blood and urine samples were collected from the exposed employees and counted for radioactive substances,  $\text{Na}^{24}$  in the blood and  $\text{P}^{32}$  and  $\text{Na}^{24}$  in the urine. A burro was exposed to a mock-up of the liquid assembly to determine the relationship of  $\text{Na}^{24}$  activity in the blood and neutron dose. The ratio of  $\gamma$  dose to neutron dose for this particular type of critical assembly was determined with the mock-up experiment. Theoretical calculations of the gamma to neutron dose were also determined. (C.J.G.)

**3713**

INTEGRITY OF VINYL PLASTIC SUITS IN TRITIUM ATMOSPHERES. H. L. Butler and R. W. Van Wyck (E. I. du Pont de Nemours & Co., Aiken, S. C.). *Health Phys.* **2**, 195-8(1959) Oct.

Significant amounts of tritium oxide penetrate vinyl plastic suits when exposed to high level concentrations. The degree of penetration can be estimated from data obtained during control tests. Exposures of personnel using the suits can be controlled by establishing working time limits based on the expected penetration. Laundering does not appear to affect the over-all permeability of the plastic. The test data permit extensive use of the inexpensive two-piece suit, resulting in considerable cost savings in a tritium protection program. (auth)

**3714**

SELECTED MATERIALS ON FEDERAL-STATE COOPERATION IN THE ATOMIC ENERGY FIELD. JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, MARCH 1959. Washington, D. C., Joint Committee on Atomic Energy, 1959. 526p. (GPO)

Excerpts from the Atomic Energy Act of 1954, and proposed amendments to this act are given. Reports are contained which summarize the activities of Federal, State, local agencies, and certain nongovernmental organizations in the field of atomic energy relative to regulation of radiation hazards and the Federal and State responsibilities for radiation protection. Articles, legal analyses, and a bibliography on Federal-State cooperation in atomic energy are included. (C.J.G.)

**3715**

DEUTSCHE ATOMKOMMISSION. FACHKOMMISSION IV (STRAHLENSCHUTZ) REFERATENSAMMLUNG. (German Atomic Commission. Commission on Radiation Protection Data. Abstract Collection). No. 5 of "Schriftenreihe des Bundesministers für Atomkernenergie und Wasserwirtschaft. Strahlenschutz." Brunswick, Ger., Gersbach & Sohn Verlag GmbH., 1958. 130p. DM 4.

Reports presented to the German Atomic Commission on radiation measurement methods, radiation protection in working with radioactive materials, and radiobiology are compiled. The topics considered include latest methods in radiation measurement techniques, measurement methods for radioactivity determinations in air, water, soils, flora, and fauna, determination of very low activities in water, radiation standards, permissible doses, radiation protection precautions in the US and UK, distribution and effects of incorporated radioactive materials, radiohematology as center of radiobiological research, genetic effects of radiation in man, radiosensitivity during hibernation, biological basis of radiohematology, and radiation damage to genes. (J.S.R.)

## ISOTOPE SEPARATION

**3716** AERE-Trans-836

ELECTROLYTIC SYSTEMS WITH COLUMNS FOR THE RECOVERY OF DEUTERIUM BY THE EXCHANGE REACTION. III. STUDY OF FOUR-STAGE SYSTEMS WITH COLUMNS CONSISTING OF CONDENSATION PLATES, WITH PARTICULAR REFERENCE TO THE YIELD AND OTHER CHARACTERISTIC PARAMETERS. ECONOMIC CONSIDERATIONS CONCERNING THE RECOVERY OF DEUTERIUM. (Impianti Elettrolitici Con Colonne di Recupero del Deuterio A Reazione di Scambio. III. Studio di Impianti a 4 Stadi con Colonne Costituite da Piatti a Condensazione con Particolare Riferimento Alla Resa e Agli Altri Parametri Caratteristici. Considerazioni Economiche Sul Limite Di Convenienza del Recupero del Deuterio). E. Cerrai, C. Marchetti, M. Silvestri, and S. Villani. Translated by J. B. Sykes from report CISE-63. 36p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, as abstract No. 8612.

**3717**

STUDY OF THE SEPARATION OF URANIUM ISOTOPES. G. Fréjacques. *Énergie nucléaire* **1**, 217-21(1959) Sept.-Oct. (In French)

The gaseous diffusion process is discussed with particular attention to the problems of barriers. (T.R.H.)

**3718**

THE FRACTIONATION OF OXYGEN ISOTOPES BETWEEN WATER AND SULFUR DIOXIDE. L. L. Brown and J. S. Drury (Oak Ridge National Lab., Tenn.). *J. Phys. Chem.* **63**, 1885-6(1959) Nov.

The isotopic fractionation of oxygen between water and sulfur dioxide was measured at 21°C. The experimental value (1.016) agreed well with a theoretical value calculated from Urey's data (1.014). Oxygen-18 concentrated in the gas phase. (auth)

**3719**

CARBON ISOTOPE FRACTIONATION IN BACTERIAL PRODUCTION OF METHANE. William D. Rosenfeld and Sol R. Silverman (California Research Corp., La Habra). *Science* **130**, 1658-9(1959) Dec. 11.

Anaerobic bacteria from a Pacific Ocean mud cause unusually large carbon isotope fractionations during ferment-



tation of methanol. The methane produced is about 8 percent enriched in  $C^{12}$ , relative to the original methanol. Fractionation factors determined at 30°C and 23°C were 1.081 and 1.094, respectively, which indicates that this process is dependent on temperature. (auth)

**3720**

PROGRESS IN NUCLEAR PHYSICS. VOLUME 7. O. R. Frisch, ed. New York, Pergamon Press, 1959. 330p. \$14.00.

Six papers are included which summarize recent advances in the fields of bubble chambers, resonance fluorescence, in nuclei, spallation, optical model for nuclear scattering, measurement of helicity, and weak interactions. (W.D.M.)

## MATHEMATICS AND COMPUTERS

**3721**

NYO-8098

Space Technology Labs., Inc. Physical Research Lab., Los Angeles.

THE "PERSISTOR"—A SUPERCONDUCTING MEMORY ELEMENT. E. C. Crittenden, Jr., John N. Cooper, and F. W. Schmidlin. [1959]. 49p.

The basic components of a Persistor memory element are a superconducting inductor in parallel with a switch element which is normally superconducting, but which becomes resistive when the current exceeds a critical value. When a suitable current pulse is applied to a Persistor memory element, a persistent circulating current is stored. A second pulse in the same direction as the first makes no change, but a pulse in the opposite direction reverses the circulating current and produces a voltage across the element. By mutual inductance coupling to two or more driving circuits, these memory elements can be made to operate in matrices similar to those employed with ferromagnetic cores. Persistor memory elements utilizing Pb inductors and thin Sn or In films have performed typical memory unit functions for pulses of 15 millimicroseconds ( $\mu\text{sec}$ ) duration and a repetition rate of 15 megacycles. Performance at higher speeds is possible. The limiting speed is determined by the thickness of the thin film switch element and can be made as fast as is useful for the other parts of the associated circuits. The elements are well suited to compact printed circuit production with densities of a million per cubic foot possible. (auth)

## METALS, CERAMICS, AND MATERIALS

### General and Miscellaneous

**3722**

BM-RI-5539

Bureau of Mines.

HIGH-PURITY TUNGSTEN BY FLUORIDE REDUCTION. V. A. Nieberlein and H. Kenworthy. 1959. 12p.

Tungsten metal was produced in massive form on a laboratory scale by hydrogen reduction of tungsten hexafluoride ( $\text{WF}_6$ ). Metal made had a purity of 99.99% or better, with reference to all detectable impurities, including gases. The process tolerated a wide variation in operating conditions, and the results with respect to total impurities as low as 0.01% were reproducible. Tungsten was deposited

in the form of columnar crystals having a specific gravity of 19.25, as determined by water displacement. This compares favorably with 19.23 for commercial, drawn tungsten wire. Efficiency of the process varied from 91 to 97%, based on the quantity of  $\text{WF}_6$  consumed. (auth)

**3723**

CF-59-7-1

Oak Ridge National Lab., Tenn.

ZIRCONIUM DIBORIDE, BORON NITRIDE, AND BORON CARBIDE COMPATIBILITY WITH AUSTENITIC STAINLESS STEEL. Julian H. Cherubini and C. F. Leiften, Jr. July 31, 1959. 19p. Contract [W-7405-eng-26]. OTS.

The compatibility of zirconium diboride, boron carbide, and boron nitride with type 304 stainless steel was evaluated as a function of temperature (1000 to 1200°C), time (1-3 hr). Appropriate loadings of the boron compounds and stainless steel powder were blended and fashioned into a compact powder metallurgically. Each compact was roll clad into a plate and subsequently heat treated at a temperature equal to the initial sintering temperature. Metallographic examination of the fabricated and heat-treated plates demonstrated that none of the systems was metallurgically stable. The instability was generally manifested by the interaction of the discrete boron compounds with the matrix and precipitation of a hypothetically boron-rich phase throughout the stainless steel matrix material. Of the three compounds, boron nitride was relatively the most stable in a stainless steel matrix under the test conditions. (auth)

**3724**

EXP-NRX-1806

Atomic Energy of Canada Ltd., Chalk River, Ont.

CHEMISTRY OF DEFECT TEST ON HIGHLY RATED SINTERED  $\text{UO}_2$  FUEL. Test X-2-q. G. M. Allison and I. H. Crocker. June 1959. 27p. (AECL-906).

A highly rated ( $\int k_{\text{eff}} d\theta = 48 \text{ W/cm}$ ) sintered  $\text{UO}_2$  specimen, 0.8 in. O.D., with a 0.010-in. diameter hole through the Zircaloy sheath, was irradiated in the X-2 loop in the NRX reactor for approximately 16 days. For this irradiation period the escape-rate coefficients calculated for the fission products  $\text{Kr}^{88}$ ,  $\text{Cs}^{138}$ ,  $\text{I}^{135}$ ,  $\text{I}^{133}$ , and  $\text{I}^{131}$  were similar to those found in previous defect tests on  $\text{UO}_2$  fuel operated at considerably lower heat ratings. The test was terminated due to high activity in the loop water which occurred during a reactor trip-startup cycle. Post-irradiation examination of the defected fuel element indicated no reason for the activity surge. (auth)

**3725**

HW-61272(Rev.)

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

INTERIM REPORT ON THE HYDROSTATIC DESTRUCTIVE TESTING OF ZIRCALOY-2 PRESSURE TUBING. V. E. Kahle. Oct. 15, 1959. 51p. Contract AT(45-1)-1350. OTS.

This investigation was undertaken to: obtain ultimate strength and creep rupture data on Zircaloy-2 tubing to be used in conjunction with other considerations for the establishment of safe operating limits for the PRTR and NPR; study the fracture characteristics of Zircaloy-2 tubing; and determine if there is a correlation between tensile strength, as determined from standard tensile specimens made from strip, and actual burst strengths of tubing. Burst test equipment, instrumentation, and end closures were developed to make possible the testing of Zircaloy pressure tube sections at elevated temperatures. This equipment has evolved to the point where it is now possible to obtain reproducible and accurate ultimate strength data on tube sections up to 30 inches in length. Pictures, sketches, and a discussion of the equipment are presented.

Burst test data on 20 Zircaloy-2 tubes are included and discussed. A short discussion of fracture characteristics and strength of tubing as opposed to strip is presented. The following conclusions were reached. The equipment, instrumentation, and test procedures were developed to the point where reasonably accurate data now may be obtained. The Zircaloy-2 tubes have a higher ultimate strength than predicted on the basis of tensile data obtained from Zircaloy-2 strip. Zircaloy-2 tubing in the annealed, as-extruded and 5 to 17.8% cold-worked conditions fails in a ductile manner at 300°C when an internal pressure is applied. The fractured surfaces are inclined approximately 45 degrees to the direction of the principal stress indicating the mode of fracture is shear. The increase in ultimate strength of tube sections over tensile specimens may be due to the biaxial stress conditions and the crystallographic preferred orientation present in the tubes. (auth)

**3726** MND-SF-1769

Martin Co. Nuclear Div., Baltimore.

SWAGED METAL FIBER- $\text{UO}_2$  FUEL ELEMENT. Quarterly Progress Report No. 3 from June 15, 1959 to September 15, 1959. John Kane. Oct. 1959. 51p. Contract AT(30-1)-2220, Task III. OTS.

A mathematical analysis of fiber distribution was made to determine the effect of addition of fiber to  $\text{UO}_2$ . The development of a suitable thermal conductivity test for the swaged fuel element is outlined. (W.L.H.)

**3727** NAA-SR-3703

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

PROCESSING REFABRICATION EXPERIMENT (PRE) PROGRAM BIBLIOGRAPHY. G. L. Schalin. Nov. 15, 1959. 13p. Contract AT(11-1)-GEN-8. OTS.

A listing is presented of all documents concerning the Pyroprocessing Refabrication Experiment (PRE), later renamed Processing Refabrication Experiment, from its inception as a project under AEC Contract AT(11-1)-GEN-8, General Order 7501, in June 1956, until its phase-out in July 1959. Also listed are documents released prior to the establishment of the Pyroprocessing Refabrication Experiment program at Atomics International that contain essential technical information upon which the PRE was based. (auth)

**3728** NP-8085

Narmco Industries Inc., San Diego, Calif.

DEVELOPMENT OF EXO-REACTANT INORGANIC ADHESIVE SYSTEM. Quarterly Progress Report No. 5 Covering Period July 1-September 30, 1959. William Bassett, William Boram, and Roger A. Long. Oct. 1, 1959. 54p. Contract NOas-58-857-c.

Investigation was continued on the development of an Exo-Reactant adhesive system. Lap Shear strengths in excess of 4160 psi were developed in the bond with fracture in the 302 stainless steel outside the half-inch bonded area. Highly ductile bonds were evident throughout. Two types of basic adhesive systems were investigated, a "Metal-Glass Forming" System and an "Oxide-Metal" System. In the former system the metal phase was deposited on the stainless steel surfaces and the fluid glass phase (flux) was squeezed out of the bond line. In the latter system a homogeneous mixture of oxides and metals remained in the bond line and served as the adhesive. A greater rate of effort was placed on the "Metal-Glass Forming" adhesive development. Additional development work was done on the use of organic bound exo-reactants particularly in the form of tape. Evaluations to date have shown the possibility of producing satisfactory tape, how-

ever, there seems to be a marked inhibition of the metal phase to wetting the stainless surfaces. In addition, gas liberation due to the carrier scrim presents a problem which seems inherent with the technique. (For preceding period see NP-7880.) (auth)

**3729** ORO-218

National Carbon Co., Fostoria, Ohio.

FUEL CYCLE DEVELOPMENT PROGRAM. Monthly Newsletter [for] September 1959. R. L. Robinson. Oct. 13, 1959. 11p. Contract AT(40-1)-2560. OTS.

A series of  $\text{U}_3\text{O}_8$ -graphite blends was made to determine the content and variation of the  $\text{U}_3\text{O}_8$  by various blending methods. Analysis of sample fuel elements baked to 2100 and 2800°C have shown U present as  $\text{U}_3\text{O}_8$  instead of the desired or expected  $\text{UC}_2$  and UC. This indicated that precautions taken during packing and baking were not adequate to exclude all traces of oxygen from the bake. Data are presented on heat generation rates of graphite dispersion type fuel elements. (W.L.H.)

**3730** ORO-221

Carborundum Co., Niagara Falls, N. Y.

SYNTHESIS AND FABRICATION OF REFRACTORY URANIUM COMPOUNDS. Monthly Progress Report No. 4 for October 1 to October 31, 1959. K. M. Taylor, C. A. Lenie, P. A. Smudski, L. N. Hailey, and T. J. Keaty. Nov. 10, 1959. 5p. Contract AT(40-1)-2558. OTS.

When U metal or a mixture of uranium oxide and carbon are nitrated at 1700°C and cooled in a nitrogen atmosphere, the higher nitrides,  $\text{UN}_3$  or  $\text{U}_2\text{N}_5$  are obtained. Uranium nitrides are also formed when a mixture of uranium diuranate and carbon is nitrated at 1700°C. About 300 grams of  $\text{U}_3\text{Si}_2$  was prepared by quenching small melts of U and Si. (W.L.H.)

**3731** WAL-TR-405/1

Watertown Arsenal Lab., Mass.

CHROMIUM PLATING ON TITANIUM ALLOYS. Charles Levy. Nov. 1959. 22p. DA Project 5B93-32-003. OTS.

Experimental work was carried out on electrodeposition of chromium on titanium alloys. Methods for plating on titanium were investigated and evaluated. Average adhesion values ranged from 572 to 5785 psi for the various methods, with the method developed by Brenner and Stanley showing the highest value. Deposits prepared by commercial firms utilizing proprietary processes were also evaluated. Acid immersion zinc deposits which offer promise of conditioning titanium surfaces for electroplating were developed in laboratory experimentation. More research is needed to achieve adhesion of chromium plate to titanium comparable to that obtained on steel, which is of the order of 40,000 psi. (auth)

**3732** WAPD-T-586

Westinghouse Electric Corp. [Atomic Power Div., Pittsburgh].

AN ELECTRON MICROSCOPY TECHNIQUE FOR STUDYING SHAPE, SIZE AND DISTRIBUTION OF PORES IN SINTERED  $\text{UO}_2$  COMPACTS. Thomas R. Padden. [195?]. 17p. Contract AT-11-1-GEN-14. OTS.

A chromium backed carbon replica technique, which is being used to study the change in pore structure associated with sintering of  $\text{UO}_2$ , is described. Some of the results and interpretations are also included. In this technique, as-fractured planes with the pores exposed are replicated with carbon, which is then backed with an evaporated chromium film containing numerous holes or windows. The composite film is etch released and manipulated without additional backing. The replica is either pre-shadowed with platinum or post-shadowed with platinum or uranium.



Using this technique, it was found that at certain stages of sintering the closed pores become octahedrons, truncated octahedrons and/or truncated spheres with the {111} and {100} planes developed, and the orientation of a pore is related to that of the grain in which it is located. Concentric growth steps about 50 Å high with their centers along the [110] directions were also observed. Light and electron micrographs of chemical and cathodic vacuum etched surfaces are included for comparison. (auth)

### 3733 WAPD-ZH-20

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

ZIRCONIUM HIGHLIGHTS. Sept. 1959. 22p. Contract AT-11-1-Gen-14. OTS.

Research on hydrogen pickup during high-temperature corrosion of Zircaloy-2 and -4 is reported. Work on the identification and sources of  $N_2$ -rich inclusions in Zircaloy-2 is presented. An investigation was made to determine whether or not dialysis is a feasible means of cutting down Zircaloy-2 pickling costs by recovering  $HF-HNO_3$  and by decreasing disposal volume. The corrosion behavior of Fe contaminated Zircaloy-2 in water and steam was investigated. The relationship between Knoop and Diamond Pyramid hardness of Zircaloy-2 was determined. (For preceding period see WAPD-ZH-19.) (W.L.H.)

### 3734 CEA-tr-R-717

DISPOSITIF PERMETTANT DE PHOTOGRAPHIER LA SURFACE DÉVELOPPÉE DE LA FACE LATÉRALE D'UNE ÉPROUVETTE CYLINDRIQUE LORS D'ESSAIS DE CORROSION. (Apparatus Permitting the Photography of the Developed Surface of the Lateral Face of a Cylindrical Sample During Corrosion Tests). S. N. Alekseev. Translated into French from *Zavodskaya Lab.* 24, 108-9(1958). 6p.

In the utilization of cylindrical samples for corrosion tests, difficulties connected to the fixation of the image of the propagation of the corrosion effects cause incomplete photographic representation of the corrosion. An apparatus was constructed which permits the lateral face of the developed cylinder to be photographed. A cross section sketch of the device and a sample photograph are given. (J.S.R.)

### 3735 JPRS-1038-D

METALLURGICAL ACHIEVEMENTS IN THE DEVELOPMENT OF HIGH-TEMPERATURE (HEAT-RESISTANT) STEELS AND ALLOYS FOR GAS TURBINE CONSTRUCTION. P. B. Mikhaylov-Mikheyev. Translated from *Teploenergetika*, No. 10, 3-8(1959). 15p. OTS.

Factors affecting the selection of metals and alloys for use in gas turbines are examined. Also, the status of research and development of heat-resistant steels and alloys is reviewed. It is concluded that the metallurgy of high-temperature alloys has reached a stage of development such that the gas turbine construction industry can be supplied with materials capable of operating under stress at 800°C in stationary turbines with long operating times and at 900 to 1000°C in turbine units with shorter operating periods. (J.R.D.)

### 3736 JPRS-L-1104-N

SOME QUESTIONS CONCERNING THE PRODUCTION OF TITANIUM BY MEANS OF MOLTEN MEDIA ELECTROLYSIS USING SOLUBLE ANODES. A. B. Suchkov, B. A. Borok, M. I. Rodnyy, T. N. Yermakova, Z. I. Morozova, and L. D. Boldina. Translated from *Tsvetnye Metal.*, No. 8, 50-4(1959). 9p. OTS.

Studies of electrolytic refinement of Ti for removal of impurities such as O, N, H, and C were conducted. Pro-

cedures and apparatus are described. Results showed that the best possibility of obtaining technically pure Ti from compounds such as  $TiO$ ,  $TiN$ , and  $TiC$  is to use material of relatively low impurity content. In electrolytic refinement from previously nitrified slag a cathode metal was obtained which contained 98 to 99% Ti. (J.R.D.)

### 3737 JPRS-L-1951-D

METALLURGY OF NICKEL. A. A. Tseydler. Translated from p.357-60; 369-81 of "Metallurgiya Medi i Nikelya," Metallurgizdat, Moscow, 1958. 22p. OTS.

Preparation of nickel by the carbonyl process is described. The method is based on the reversible reaction  $Ni + 4 Co \rightarrow Ni(CO)_4 + 40,000 \text{ cal}$ . Comment on equilibrium aspects of the reaction are included along with methods of separating nickel carbonyl from cobalt and iron carbonyls. In addition, electrolytic refining of nickel is discussed and process data on this method are tabulated. (J.R.D.)

### 3738 NP-tr-312

JOURNAL OF INORGANIC CHEMISTRY. Translation of Zhur. Neorg. Khim. 3, No. 4 (1958). [Contains Papers and Discussions of a Conference on the Study of Phase Diagrams of Metallic Systems, held May 17-21, 1957, at Moscow]. 392p. OTS.

Thirty-four papers on phase diagrams for metals are included. Separate abstracts were prepared for each paper. (J.R.D.)

### 3739 NP-tr-312(p.1-9)

CONTRIBUTION TO THE QUESTION OF THE FORMATION OF CONTINUOUS SERIES OF SOLID SOLUTIONS IN THE SYSTEMS FORMED BY CARBIDES, NITRIDES, BORIDES AND SILICIDES OF METALS OF THE TRANSITION GROUPS. R. B. Kotelnikov. 9p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 12, as abstract No. 15496.

### 3740 NP-tr-312(p.11-21)

STUDY OF SOLUBILITY AND PHASE COMPOSITION IN THE SYSTEM SILICON-CARBON. I. S. Brokhin and V. F. Funke. 11p.

The phase composition of alloys of the system C-Si at 0 to 95% C was studied. The existence of a region of limited solubility of C in Si (0.6% C) was established, together with the position of the boundary of this region at 1350°C. Quantitative data were obtained on the dissociation of SiC in vacuo at 1900 to 2100°C. (J.R.D.)

### 3741 NP-tr-312(p.22-35)

STUDY OF PHASE DIAGRAM OF NICKEL-MOLYBDENUM-CHROMIUM. A. P. Smiryagin, A. Ya. Potemkin, and R. P. Martynyuk. 14p.

The nickel corner of Cr-Mo-Ni alloy phase diagram was investigated at concentrations up to 40% Mo and 40% Cr using thermal and microscopic analyses. Eight polynomial sections were constructed. The solubility of Mo and Ni in Ni decreases with decreasing temperature. Hardness and temperature coefficient of resistivity were determined after annealing and quenching from 1200, 950, 800, and 750°C, and the hardness of vacuum-cast alloys was also determined at intervals from 20 to 1000°C. (J.R.D.)

### 3742 NP-tr-312(p.36-43)

THE PHASE DIAGRAM OF THE SYSTEM COLUMBIUM-TUNGSTEN. V. S. Mikhe'ev (Mikheyev) and D. M. Pevtsov. 8p.

Aspects of Nb-W phases were studied by physicochemical methods such as thermal analysis, and studies of microstructure, hardness, and resistivity. Equilibrium diagrams showed that solid solutions are formed in the system

upon crystallization of the alloys. The hardness of the alloys in the annealed and quenched states varies discontinuously. The alloys with 10 to 20% have the highest hardness. The lowest hardness (200 and 300H<sub>v</sub>) is displayed by alloys of 40 and 50% W, respectively. (auth)

**3743** NP-tr-312(p.44-5)

SOME DATA ON THE EQUILIBRIUM DIAGRAM OF THE SYSTEM CHROMIUM-COLUMBIUM. V. F. Funke and V. P. Yelyutin. 2p.

Information is presented in the form of questions and answers on crystal structure, accuracy of liquidus-solidus points, and melting point of Nb at 2100°C as presented in a diagram. (J.R.D.)

**3744** NP-tr-312(p.46-62)

STUDY OF THE PROPERTIES OF ALLOYS OF THE COLUMBIUM-SILICON SYSTEM. G. V. Samsonov, V. S. Neshpor, and V. A. Yermakova. 17p.

Phase studies of the Nb-Si system at 0 to 100 at. % Si are reported. X-ray-diffraction and metallographic methods were used. Structures and formulas of intermediate silicides are listed and the melting point of various alloys was established. Electric conductivity data are given and the phase diagram is represented in preliminary form. Oxidation resistance of these alloys was studied. They are not corrosion-resistant. (J.R.D.)

**3745** NP-tr-312(p.63-78)

PHASE DIAGRAM OF THE TERNARY SYSTEM TITANIUM-NIOBIUM-MOLYBDENUM. I. I. Kornilov and R. S. Polyakova. 16p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 12, as abstract No. 15576.

**3746** NP-tr-312(p.79-93)

THE PHASE DIAGRAM OF THE TERNARY SYSTEM CHROMIUM-TUNGSTEN-MOLYBDENUM. N. V. Grum-Grzhimaylo and D. I. Prokof'ev (Prokof'yev). 15p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 12, as abstract No. 15577.

**3747** NP-tr-312(p.94-103)

SOME PROPERTIES OF ALLOYS OF THE BORIDES OF THE REFRACTORY METALS OF THE TRANSITION GROUPS. G. A. Meyerson, G. V. Samsonov, R. B. Kotelnikov, M. S. Voynova, I. P. Yevte'eva (Yevteyeva), and S. D. Krasnenkova. 11p.

The systems  $\text{CrB}_2$ - $\text{TiB}_2$ ,  $\text{TiB}_2$ - $\text{W}_2\text{B}_5$ , and  $\text{CrB}_2$ - $\text{ZrB}_2$  are investigated. The phase composition of the starting boride diffusion interaction products, phase microhardness, and the heat resistance and structure of various compositions formed in these systems are examined.  $\text{CrB}_2$ - $\text{TiB}_2$  was found to form a continuous series of solid solutions, while solubility in the systems  $\text{TiB}_2$ - $\text{W}_2\text{B}_5$  and  $\text{CrB}_2$ - $\text{ZrB}_2$  is limited. The solubility of  $\text{TiB}_2$  in  $\text{W}_2\text{B}_5$  does not exceed 10 and 5 mole %, respectively. The solubility of  $\text{ZrB}_2$  in  $\text{CrB}_2$  is about 20 mole %. The solubility of  $\text{CrB}_2$  in  $\text{ZrB}_2$  is apparently slight. (J.R.D.)

**3748** NP-tr-312(p.104-15)

CONTRIBUTION TO THE QUESTION OF THE PHASE DIAGRAM OF THE SYSTEM IRON-COBALT-SULFUR. N. G. Moleva, P. S. Kusakin, Ye. A. Vetrenko, and N. P. Die'ev (Diyev). 12p.

This ternary system was investigated from the pseudo-binary sections  $\text{FeS-Co}_3\text{S}_2$  to systems containing 15% S by thermo, microstructural, and dilatometric methods. In addition, a portion of a phase diagram was constructed by use of data on specific gravity and microhardness. Three sur-

faces of primary crystallization were established. Solubility data are given and it was found that the portion of the diagram under study consists of eight structural regions. (J.R.D.)

**3749** NP-tr-312(p.116-22)

CONTRIBUTION TO THE QUESTION OF THE PREPARATION OF METALS AND ALLOYS BY INTERACTION OF SALTS WITH METALS IN THE MOLTEN STATE. A. P. Palkin. 7p.

Displacement reactions in which metals are displaced from salts of the halide type by other metals in the molten state are investigated. Studies of systems such as  $\text{PbCl}_2 + \text{CuCl} + \text{AgCl} + 2 \text{Zn} \rightarrow 2 \text{ZnCl}_2 + \text{Cu} + \text{Ag} + \text{Pb}$ , and  $\text{CdCl}_2 + \text{ZnCl}_2 + \text{TiCl}_2 + 2 \text{Al} \rightarrow 2 \text{AlCl}_3 + \text{Cd} + \text{Zn} + 2 \text{Ti}$  make the preparation of pure metals by this method feasible and leads to a study of methods of separate and successive preparation of metals from a mixture of their salts of various compositions. (J.R.D.)

**3750** NP-tr-312(p.123-34)

CONTRIBUTION TO THE CONSTRUCTION OF THE PHASE DIAGRAM OF IRON SULFIDE-NICKEL SULFIDE-COBALT SULFIDE (UP TO 30%). N. A. Anisheva and P. S. Kusakin. 12p.

Diagrams of seven vertical (polythermal) sections of the system  $\text{FeS-Ni}_3\text{S}_2\text{-Co}_3\text{S}_2$ , and orthographic projections of the isotherms of the liquidus of the part of this system up to 30%  $\text{Co}_3\text{S}_2$  content were constructed. The order and regions of alloy crystallization of the system were determined from the liquid state down to room temperature, and phases of crystallization regions were revealed. (J.R.D.)

**3751** NP-tr-312(p.134-41)

STUDY OF THE REGION OF SEPARATION INTO LAYERS IN THE SYSTEM LEAD-COPPER. M. A. Abde'ev (Abdeyev) and O. G. Miller. 8p.

The region of layer separation in the Cu-Pb system was studied at 1000, 1100, and 1200°C. At lead concentrations of 23 to 80% the vapor pressure of the Pb over the melt is almost constant. It was also found that at temperatures greater than 1200°C the solution is homogeneous. A detailed system investigation to refine the diagram in the high-temperature region is required. (J.R.D.)

**3752** NP-tr-312(p.142-59)

SOME REGULARITIES OF THE APPEARANCE OF METASTABLE SYSTEMS OF Fe-C ALLOYS, AND THE TRANSITION OF THESE SYSTEMS TO THE STABLE STATE. I. V. Salli. 18p.

Results of an experiment to study the phase transformations taking place on the surface of steels and cast irons under heat treatment *in vacuo* are presented. The data shows that austenite of a composition close to that of the original melt is formed on the surface of hypoeutectic irons at high degrees of supercooling of the liquid. On the surface of such irons under these conditions, supersaturated cementite is formed. Other information on metastable Fe-C systems is given along with theory of transition to the stable state. (J.R.D.)

**3753** NP-tr-312(p.160-3)

X-RAY DIFFRACTION DETERMINATION OF THE SOLUBILITY LIMITS IN COARSE-GRAINED SPECIMENS BY THE OSCILLATION METHOD. Yu. A. Bagaryatski (Bagaryatskiy) and Yu. D. Tyapkin. 4p.

Solubility determination by x-ray-diffraction measurement of crystal lattice periods of solid solutions at various annealing temperatures and for various alloy compositions is described. The method is used to determine the solubility limit of Ti in Ni at 800 and 1100°C. A phase diagram is included. (J.R.D.)



**3754** NP-tr-312(p.163-9)

CONTRIBUTION TO THE THEORY OF STABILITY OF A BINARY MIXTURE. V. Ya. Yakovlev and V. I. Chervonovskii (Chervonovskiy). 7p.

The role of intermolecular forces in liquidus-solidus theory is examined from the statistical physics point of view. A system consisting of particles of two species, mixed homogeneously in any proportions was used for the investigation. A mathematical development is presented and it is pointed out that the graphic dependence of the temperature on the components concentration has a form which is similar to the usual graphs of liquidus-solidus curves. (J.R.D.)

**3755** NP-tr-312(p.169-77)

THERMODYNAMIC FUNCTIONS IN BINARY SYSTEMS. A. Krupkowski, W. Ptak, and A. Blake-Bolton. 9p.

A review of characteristic thermodynamic functions is presented in which these functions are classified and presented in relation to one mole of substance, solution, or mixture. Examples in the cadmium-zinc equilibrium system are investigated and data are presented graphically. (J.R.D.)

**3756** NP-tr-312(178-84)

THE ROLE OF COVALENT BONDS IN THE INTERMETALLIC  $A_3B$  PHASES WITH THE  $\beta$ -W STRUCTURE. Theodor Millner. 7p.

The unusually short interatomic distances in  $\sigma$ -phases and the brittleness found in Cr-iron  $\sigma$ -phases leads to a postulation that the atoms in chains of this type are bound to each other by covalent bonds. It is then established that all known  $\sigma$ -phases contain atoms (Cr, V, Mo, and W) which, in intermetallic  $A_3B$ -phases with  $\beta$ -W structure, form atomic chains with anomalously small interatomic distances bound together by covalent bonds. (J.R.D.)

**3757** NP-tr-312(p.190-8)

STUDY OF THE PHYSICO-CHEMICAL PROPERTIES OF PLUTONYL FLUORIDE. I. F. Alenchikova, L. L. Zaitseva (Zaytseva), L. V. Lipis, N. S. Nikola'ev (Nikolayev), V. V. Fomin, and N. T. Chebotarev. 10p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 15442.

**3758** NP-tr-312(p.199-209)

STUDY OF THE PHYSICO-CHEMICAL PROPERTIES OF AQUEOUS SOLUTIONS OF PLUTONIUM(IV) OXALATE AND DETERMINATION OF ITS SOLUBILITY PRODUCT. A. I. Moskvina and A. D. Gel'man. 11p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 15443.

**3759** NP-tr-312(p.210-30)

DETERMINATION OF THE COMPOSITION AND INSTABILITY CONSTANTS OF OXALATE AND CARBONATE COMPLEXES OF PLUTONIUM(IV). A. I. Moskvina and A. D. Gel'man. 21p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 15444.

**3760** NP-tr-312(p.231-47)

THE SALICYLATES OF PLUTONIUM. O. Ye. Zvyagintsev and B. N. Sudarikov. 17p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 15445.

**3761** NP-tr-312(p.248-64)

ON CERTAIN CHEMICAL PROPERTIES OF THORIUM AND URANIUM. A. G. Karabashch. 17p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 15343.

**3762** NP-tr-312(p.265-75)

COMPLEX COMPOUNDS OF IRIIDIUM AND RHODIUM WITH THIOUREA, AND THEIR APPLICATION TO THE SEPARATION AND DETERMINATION OF THESE METALS. N. K. Pshenitsyn and I. V. Prokof'eva (Prokof'yeva). 11p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 15344.

**3763** NP-tr-312(p.276-85)

THE POLAROGRAPHIC BEHAVIOR OF GERMANIUM ON A MERCURY DROP ELECTRODE. M. N. Platonova. 10p.

The polarographic behavior of Ge in various background electrolytes was investigated to determine the reversibility of its reduction on dropping mercury electrodes. Half-wave potentials were determined, and the constants of the diffusion currents were calculated. Results indicate the non-reversible character of the tetravalent ion in  $NH_4Cl$  and  $NH_4OH$  and the reversibility of the divalent ion in HCl solution. (J.R.D.)

**3764** NP-tr-312(p.286-319)

STUDY OF THE COMPLEX COMPOUNDS OF DIVALENT RHENIUM. A. S. Kotelnikov and V. G. Tronev. 34p.

Preparation of new divalent rhenium compounds is discussed and methods of separating them from solutions in solid state are examined. It was found that by reduction of a  $KReO_4$  mixture with hydrogen these compounds are obtained.  $ReCl_5 \cdot 4H_2O$  and  $H_2 ReCl_4 \cdot 2H_2O$  were separated as crystals and thermographic studies were made as well as experiments on hydrolysis and reactions with pyridine and other organic compounds. Separation methods are described and data and observations are included. (J.R.D.)

**3765** NP-tr-312(p.320-33)

SOLUBILITY DIAGRAMS OF URANYL AND THORIUM NITRATES WITH SALTING-OUT AGENTS. A. G. Kurnakova and A. V. Nikolae'ev (Nikolayev). 14p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 15345.

**3766** NP-tr-312(p.334-47)

THE ISOCONCENTRATE OF THE SYSTEM  $UO_2(NO_3)_2 - NH_4NO_3 - HNO_3 - (C_2H_5)_2O - H_2O$ . A. V. Nikolae'ev (Nikolayev) and A. G. Kurnakova. 14p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 15456.

**3767** NP-tr-312(p.348-54)

THE PHASE-COMPOSITION DIAGRAM OF THE CRYOLITE CORNER OF THE SYSTEMS  $Na_3AlF_6 - Al_2O_3 - MgF_2$  AND  $Na_3AlF_6 - AlF_3 - MgF_2$ . E. Batslavik and A. I. Belya'ev (Belyayev). 7p.

The crystallization point, density, electric conductivity, contact angles, and aluminum losses were studied for alloys in the cryolite corner of these systems. The presence of  $MgF_2$  increases the density contact angles of these systems, but lowers the initial crystallization point, the electric conductivity, and solubility losses of aluminum. (J.R.D.)

**3768** NP-tr-312(p.355-65)

STUDY OF SOLUTIONS BY THE METHOD OF THERMOMETRY. S. D. Gromakov and R. S. Suleymanova. 11p.

Development of a method in which solutions are studied by the effects of mixing at definite ratios is discussed. Experimental techniques and apparatus are described. It was found that when clearly expressed point of equivalence is present on the temperature curves, arbitrary thermometry may be used for analytical purposes. The accuracy of this method is less than that for the classical methods, but the applications are much wider. The method may be effectively used in qualitative studies. Examples of application are included. (J.R.D.)

**3769** NP-tr-312(p.366-76)

THE MECHANISM OF MIGRATION OF RADIUM AND THORIUM ISOTOPES. V. I. Baranov, A. M. Babshkin, K. B. Zaborenko, and S. V. Pirozhkov. 11p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, as abstract No. 15519.

**3770** NP-tr-312(p.377-80)

GERMANIUM DISULFIDE. S. V. Ivanova and V. I. Davydov. 4p.

Preparation of germanium disulfide obtained in the reaction of hydrogen sulfide and sulfur vapor with powdered metallic germanium is described. Observations on properties are given along with results of x-ray structural analysis. (J.R.D.)

**3771** NP-tr-312(p.380-3)

THE SPECIFIC GRAVITY OF LIQUID OZONE. Ye. I. Grifbova, S. A. Kamenetskaya, and S. Ya. Pshezhetskii (Pshezhetskii). 4p.

Specific gravity measurements of liquid ozone by determination of the pressure drop in a U-shaped ozone manometer are reported. Techniques are described and data are tabulated. (J.R.D.)

**3772**

A STUDY OF ADSORPTION LAYERS ON THE SURFACE OF LIQUID METALS. N. L. Prokrovskii and D. S. Tissen (Lomonosov Moscow State Univ.). Doklady Akad. Nauk S.S.S.R. 128, 1228-31 (1959) Oct. 21. (In Russian)

The influence of thallium and antimony on  $\sigma$ -phase liquid tin was studied. The adsorption and surface tension isotherms of tin-thallium  $\sigma$  solutions were measured at 270 to 450° with concentrations of thallium from 0.18 to 1.96 at.% and of tin-antimony at 300 to 450° with antimony concentrations from 0.50 to 5.90 at.%. (R.V.J.)

**3773**

LUMINESCENCE PROCESSES IN THE KCl:Tl PHOSPHOR IN A MULTIDIMENSIONAL CONFIGURATION SPACE. Hiroshi Kamimura and Satoru Sugano (Tokyo Univ.). J. Phys. Soc. Japan 14, 1612-21 (1959) Nov.

To explain the 3050A and 4750A emissions of KCl:Tl phosphor which are raised by excitation in any of the absorption bands, a multidimensional configuration coordinate model is introduced. This is achieved by taking into account the Jahn-Teller effect for the excited states of the thallium ion. The Jahn-Teller effect is treated by means of an intermediate coupling scheme within the 6s6p configuration, because the mixing of the  $^3P$  and  $^1P$  states by the spin-orbit interaction is essential to understand the optical properties. It is shown that introduction of a tetragonal distortion of the emission center is able to explain the luminescence processes of this phosphor both semi-quantitatively and qualitatively. Under the tetragonal and trigonal distortions, both the crossing of the pure spin sin-

glet  $^1P$  and triplet  $^3P$  curves and the appearance of two minima in the  $^3P_1$  energy curves are expected. The former accounts for the non-radiative transition from the  $^1P_1$  state to the  $^3P_1$  state and the latter does for the two emission bands. The two types of distortions are equally able to give semi-quantitative agreement of the relative strengths of the absorption and emission bands with experiments, but only the tetragonal distortion explains the polarization of the 3050A emission observed. Johnson and Williams' model is criticized. (auth)

**3774**

AN EXAMPLE OF METALLURGICAL ADAPTATION OF CLASSICAL METALS TO AN ESSENTIAL PROBLEM IN THE NUCLEAR INDUSTRY: ALUMINUM AND MAGNESIUM, CANNING MATERIALS FOR FUEL ELEMENTS. J. Hérenghuel (Centre de Recherches d'Antony de la Société des Tréfleries et Laminiers, Havre, France). Mem. sci. rev. mét. 56, 273-84 (1959) Aug. (In French)

Aluminum and magnesium are of interest to the nuclear industry for fuel element cladding because of their low neutron cross section. For application in this field, the creep resistance must be improved, the deformation capacity after prolonged service must be stabilized, and the corrosion resistance to water at high temperatures must be increased. The results obtained up to the present in the study of these characteristics are reviewed. Some general metallurgical mechanisms are deduced. 36 references. (tr-auth)

**3775**

GRAIN REFINING OF URANIUM BY LOW ADDITIONS AND THERMAL TREATMENT. H. Aubert and J. Gerland. Mem. sci. rev. mét. 56, 393-402 (1959) Sept. (In French)

The effect of heat treatment on the grain size of uranium alloys with Cr, Si, Mo, Al, Ni, Fe, and Zr was investigated. The alloying element had a concentration equal to or less than 0.1% by weight. The TTT diagrams already published are used in the study, and the TTT diagram for U-0.08% Si was determined. The results obtained with fuel elements of different sizes are described. (tr-auth)

**3776**

SOME NEW TECHNIQUES FOR PREPARING SMALL QUANTITIES OF HIGH PURITY REFRACTORY METALS. D. A. Robins and I. Jenkins (General Electric Co. Ltd., Wembley, Eng.). Plansee Proc. 3rd Seminar, Reutte/Tyrol, 324-35 (1958).

A number of new techniques are described for removing trace impurities and, in particular, interstitial elements from high melting point metals such as tantalum and molybdenum. Apparatus is described for solid state purification both by resistance heating and electron bombardment and apparatus for liquid state purification by zone refining is also described. The relative merits of solid state and liquid state purification are discussed. (auth)

**3777**

METALLURGIYA KAL'TSIYA. (Metallurgy of Calcium). Nikolay Andreyevich Doronin. Moscow, Izd-vo Glav. upr. po ispol'zovaniyu atomnoy energii pri Sovete Ministrov, SSSR, 1959. 89p.

Experimental and industrial data from Soviet and other literature on the metallurgy of calcium, with special reference to the use of calcium as a reducing agent in the metallurgy of high-melting rare metals and their alloys and in the metallurgy of uranium and thorium are presented. (TCO)

**3778**

STUDY ON THE PROGRESS OF NUCLEAR MATERIALS. II. MODERATORS. C. BERYLLIUM. Paris, Organisation



for European Economic Co-Operation, 1959. 40p. (In French)

An outline is presented of the properties, utilization, fabrication, and production of beryllium and beryllium oxide. The present and future needs are briefly considered. In an appendix these data are tabulated. (J.S.R.)

## Corrosion

### 3779 CF-59-11-114

Oak Ridge National Lab., Tenn.

CORROSION RESISTANCE OF CD4MCu STAINLESS STEEL IN REACTOR-RELATED ENVIRONMENTS. D. N. Hess, R. S. Greeley, P. D. Neumann, and J. C. Griess. Nov. 30, 1959. 12p. OTS.

CD4MCu steel, either as cast or in the rolled and heat-treated condition, is as resistant to corrosion in uranyl sulfate solutions as cast or wrought type 347 stainless steel under either static or dynamic conditions at temperatures as high as 300°C. Furthermore, CD4MCu appears to be more resistant to stress-corrosion cracking in most chloride-containing environments than type 347 stainless steel. Further testing of this alloy in experimental engineering equipment is recommended. (auth)

### 3780 KAPL-2047

Knolls Atomic Power Lab., Schenectady, N. Y.

CORROSION OF INCONEL IN 600°F STATIC WATER. G. E. Galonian and H. L. Tymchyn. May 4, 1959. 22p. Contract W-31-109-Eng-52. OTS.

A series of static autoclave tests was made to establish the corrosion rate of Inconel in various waters at 600°F and to determine its resistance to intergranular corrosion and stress-corrosion cracking. Tests of Inconel 132 welds and a bimetal weld-cladding joint between Inconel and Type 308 stainless steel were also made. The test results show that the two heats of Inconel tested possess a rate of metal loss up to 9 mg/dm<sup>2</sup>-mo. No stress-corrosion cracking, intergranular corrosion, or selective attack of weld samples or cladding samples was found. Hydrogen-bearing water was the least corrosive and produced virtually no attack. The addition of ammonium hydroxide resulted in a smaller amount of corrosion than that observed with neutral water. Some effects of heat-treatment were evident in tests with ammoniated hydrogen-free water. (auth)

### 3781

INHIBITION BETWEEN 350 AND 500°C OF THE CORROSION OF MAGNESIUM BY HUMID AIR. Raymond Darras and Roger Caillat. *Compt. rend.* 249, 1517-19(1959) Oct. 19. (In French)

It is shown that the formation of a fluorided layer on the surface of magnesium raises from 350 to 490°C the temperature at which magnesium resists corrosion in humid atmosphere. The protective coating may be obtained either by the introduction of hydrofluoric acid into the humid air or by fluoridation of the surface by immersion in a bath of demineralized water containing nitric and hydrofluoric acids. In both procedures the quantity of fluorine fixed is quite small, being of the order of 0.005 mg/cm<sup>2</sup> after 600 hr exposure at 450°C to humid air containing the acid. (J.S.R.)

### 3782

EFFECTS OF BORON-CONTAINING COMBUSTION PRODUCTS ON HIGH TEMPERATURE ALLOYS. A METHOD FOR EVALUATING THE EFFECTS OF BORIC OXIDE ON HIGH TEMPERATURE ALLOYS EVOLVED FROM THE STUDY OF HIGH ENERGY FUELS. Frank J. Loprest and

Steven J. Tunkel (Thiokol Chemical Corp., [Denville, N. J.]). *Ind. Eng. Chem.* 51, No. 12, 75A-6A(1959) Dec.

The corrosive effects of boron-containing combustion products on high-temperature alloys were studied under dynamic and static conditions. Methods for the treatment of data in quantitative terms were developed. Probable mechanisms of the corrosion process were postulated. (C.J.G.)

### 3783

SOME PROPERTIES OF OXIDE FILMS FORMED DURING AQUEOUS CORROSION. J. S. Llewellyn Leach (Imperial Coll. of Science and Tech., London). *J. Inst. Metals* 88, 24-30(1959) Sept.

During the aqueous corrosion of certain alloys, sharp changes of corrosion rate are observed. The presence of corrosion-product hydrogen has been associated with these effects. Measurements of the electrical capacity and conductivity of the surface oxide layers formed on uranium alloys suggest that the effect of hydrogen is to change the conductivity without altering the thickness of the layer. The relationship between the conductivity and the rate of corrosion is discussed. (auth)

## Fabrication

### 3784 AECU-4488

General Atomic Div., General Dynamics Corp., San Diego, Calif.

URANIUM DIOXIDE TECHNOLOGY: A LITERATURE SURVEY INTERIM REPORT. D. E. Johnson and F. H. Lofftus. May 20, 1958. 18p. ADDENDUM. D. E. Johnson. July 25, 1958. 4p. Project No. 40.4. (GAMD-363 and Add.). OTS.

This report and addendum were issued separately, but are cataloged as a unit.

A literature survey of unclassified reports on the evaluation of uranium dioxide as a potential fuel material for the Maritime Gas Cooled Reactor is presented. (J.E.D.)

### 3785 ANL-FG-162

Argonne National Lab., Lemont, Ill.

THE FABRICATION OF THE FUEL ELEMENTS FOR THE TRANSIENT REACTOR TEST. Program 7.6.9. C. H. Bean, F. D. McCuaig, and J. H. Handwerk. June 1959. 30p. OTS.

A detailed description of fabrication methods used for TREAT fuel elements is presented. Photographs of equipment and assemblies are included along with tables and flowsheets. (J.R.D.)

### 3786 DMIC-Memo-38

Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio.

THE WELDING OF WROUGHT AGE-HARDENABLE NICKEL-BASE ALLOYS FOR SERVICE AT ELEVATED TEMPERATURES. W. J. Lepkowski and R. E. Monroe. Nov. 25, 1959. 21p.

Fusion and resistance welding methods for alloys comprising the age-hardenable nickel-base materials are summarized. Data on nominal composition of these alloys are tabulated along with data on welding conditions. (J.R.D.)

### 3787 MND-SF-1714

Martin Co. Nuclear Div., Baltimore.

SWAGED METAL FIBER- $\text{UO}_2$  FUEL ELEMENT. First Quarterly Progress Report from December 22, 1958 to March 15, 1959. April 1959. Lennart Sundquist. 32p. Contract AT(30-1)-2220, Task III. OTS.

A program was initiated to develop swaged metal fiber- $\text{UO}_2$  fuel elements. Development of optimum fuel element fabrication techniques for preparing thermal conductivity

samples, and determination of thermal conductivity in these elements are included. The maximum fiber length that can be satisfactorily used was found to be 0.125 in. The effects of fabrication variables on the density of swaged metal fiber- $\text{UO}_2$  elements is also being investigated. The effects of swaging reduction,  $\text{UO}_2$  powder characteristics, cladding diameter, cladding wall thickness, and end plug material are partially evaluated. Development progress of a test suitable for quantitatively determining the thermal conductivity, in a radial direction of swaged metal-fiber- $\text{UO}_2$  fuel elements is also reported. In experiments, the radial heat flux imposed on the specimens was not uniform along their length. Contributing variables are being evaluated. (J.R.D.)

### 3788 NP-8093

Alfred Univ., Alfred, N. Y.

RESISTANCE HOT PRESSING. Aug. 1959. 27p. Contract Nonr 2407(00).

Resistance hot pressing of multi-component systems of metals, intermetallics and oxides was developed as a very successful method of producing dense materials. Types of resistance furnaces utilized included a water-cooled, metal-enclosed assembly for very rapid pressing in graphite resistance dies, and one which uses graphite resistance dies, insulated with ceramic products. In many aspects, resistance hot pressing offers definite advantages over sintering methods and induction hot pressing. (auth)

### 3789 SCDC-706

Sandia Corp., Albuquerque, N. Mex.

JOINT DESIGN AND WELDING OF BORAL. F. J. Maloney. May 8, [1957]. 16p. OTS.

Presented at AEC Welding Committee Meeting at American Car and Foundry, Albuquerque, N. Mex., May 8, 1957. OTS.

Fabrication of Boral is discussed. The primary difficulties in the fabrication of items from Boral sheet arise because boron carbide is extremely hard and it is not wetted by molten aluminum. It is noted that shearing is the simplest method of cutting a straight edge. A procedure for providing an acceptable joint with the same radiation shielding properties as the sheet itself is given. Photographs of fabrication processes and finished items are included. (J.R.D.)

### 3790 YAEC-146

Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.

INVESTIGATION OF STRETCH-FORMING PROCESS FOR FABRICATION OF REACTOR FUEL ELEMENTS.

M. D'Amore. Sept. 1959. 38p. For Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1. OTS.

Three methods of manufacturing fuel rods were investigated. The methods studied were: 1. Swaging. Swaging the fuel tube after loading to attain contact between the  $\text{UO}_2$  and the tube. 2. Stretch-Forming. Stretching of the fuel tube to obtain contact between fuel and clad. 3. Compartmenting by Stretch-Forming. Segmenting the long fuel column into short sections by stretching the tube until tube contact was achieved with stainless steel discs inserted periodically along the fuel column length. The discs were then brazed to the tube I.D. surface to provide leak-tight compartments. A 0-2 mil gap between pellets and tube was obtained by this method after stretching. (auth)

### 3791

ELEVATED TEMPERATURE PROPERTIES OF MODIFIED TYPE 347 WELD METALS. Thomas J. Moore (Arcos Corp., Philadelphia). Welding J. (N. Y.) 38, 457s-74s(1959) Dec.

Two fully austenitic modified Type 347 weld metals were shown to possess stress-rupture strength superior to that of Type 347 base material at 1000, 1200, and 1300°F on the basis of all-weld-metal and transverse stress-rupture tests. One weld-metal composition was fully austenitic by virtue of high manganese (5%) and the other via high (0.12%) carbon. The stress-rupture strength of the present standard partially ferritic Type 347 weld metal was found to be above that of Type 347 base material. Annealing generally improved the stress-rupture ductility of the niobium-bearing welds. A Type 308L weld deposit was found to be below Type 304L base plate in stress-rupture strength between 1000 and 1300°F. All-weld-metal specimens of five different compositions were tested in conventional elevated-temperature tensile tests and were found to exhibit the characteristic ductility dip at 1800 to 1900°F. Standard Type 347 weld metal containing 7% ferrite exhibited the lowest ductility, with Type 308L being almost as poor. High-manganese 347 and 16Cr-8Ni-2Mo weld deposits were significantly above standard 347 weld metal in tensile ductility. The high-carbon 347 weld showed a more modest tensile ductility improvement over standard Type 347 weld metal. In hot-ductility tests the partially ferritic weld deposits, standard Type 347 and Type 308L, exhibited good hot-ductility characteristics. The fully austenitic high-manganese and high-carbon 347 weld deposits were slow to recover ductility on cooling from 2400 or 2450°F but various commercial qualification tests have shown these electrodes to be practical, usable compositions for production welding. In a brief investigation of the effect of varying rate of strain in the standard tensile test, it was indicated that rate of strain is the most significant mechanical factor in establishing tensile ductility at the "low ductility" temperature of 1800°F. (auth)

### 3792

NEW DEVELOPMENTS IN BRAZING HIGH-TEMPERATURE NICKEL-BASE ALLOYS. E. H. Kinelski (International Nickel Co., Inc., New York) and J. B. Adamec (International Nickel Co., Inc., Bayonne, N. J.). Welding J. (N. Y.) 38, 482s-6s(1959) Dec.

The presence of aluminum and titanium in age-hardenable nickel-base alloys introduces difficulties in furnace brazing. Two successful solutions to the problem are presented. One solution was the development of a new palladium-nickel brazing alloy which is self-fluxing in an argon atmosphere and is "nonaggressive" to the base metal. The second solution is the use of preplaced nickel powder on the surface to be brazed before the introduction of a molten brazing alloy into the joint. By using the latter method with the nickel-base alloys, no flux is required in an argon furnace atmosphere. Tee-brazed joints were used to observe flow, and plug- and cylinder-type joints were used to determine short-time, tensile-shear strengths at 1200°F, and stress-to-rupture at 1200 and 1500°F. Commercial brazing alloys were also evaluated on Inconel "X" age-hardenable nickel-chromium alloy in tensile-shear at 1200°F and in stress-to-rupture at 1200 and 1500°F. (auth)

## Properties and Structure

### 3793 EES-910152-A

Naval Engineering Experiment Station, Annapolis.

REPORT ON INVESTIGATION OF THE TENSILE PROPERTIES OF ANNEALED NICKEL-CHROMIUM-IRON ALLOY. M. R. Gross and H. C. Ellinghausen. Feb. 27, 1959. 37p.

The short time tensile properties of annealed 15%



chromium-7% iron-nickel base alloy over the temperature range of 70 to 700°F are presented. The properties of 13 items, consisting of bar stock, tubing, pipe, and heavy plate, were studied. In addition, moduli of elasticity, microstructure, and effect of annealing temperature were determined or investigated. A few creep tests were performed at 600 and 700°F. The prediction of elevated temperature tensile properties from room temperature tests is discussed, and nomographs are presented. (auth)

**3794** HW-47883

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

A PRELIMINARY STUDY OF THE MECHANICAL PROPERTIES OF M-257, AN ALUMINUM-ALUMINUM OXIDE ALLOY. D. E. Johnson and D. A. Patterson. Mar. 25, 1957. 13p. OTS.

At elevated temperatures, the tensile strength of the M-257 alloy was one and one-half to two times that of 1100 aluminum alloy. At these same temperatures the tensile strength of the M-257 aluminum alloy was approximately the same as the 6063 alloy. Some tendency for notch sensitivity was observed in the elevated temperature tensile tests. Inconsistent failure of notched and indented M-257 tensile specimens was encountered in each of the three series of tests. It was concluded that additional tests must be conducted on the M-257 aluminum alloy to more accurately define the deformation behavior of the material. (auth)

**3795** JPL-PR-20-373

California Inst. of Tech., Pasadena. Jet Propulsion Lab. HIGH-TEMPERATURE SHORT-TIME CREEP OF GRAPHITE. Progress Report. H. E. Martens, [Leonard] D. Jaffe, and D. D. Button. Dec. 15, 1958. 30p. Contract DA-04-495-Ord-18.

Constant-load tensile creep properties of four commercial grades of synthetic graphite are determined at 3000 to 5300°F for periods of time up to 8 hr. The specimens tested have a gauge section  $\frac{1}{4}$ -in. diameter by 1-in. length and are heated in helium by an external graphite heater. Creep rates of  $10^{-7}$  to  $10^{-3}$  sec<sup>-1</sup> are observed at stresses of 1600 to 4000 lb/in<sup>2</sup>. The creep rate increased continuously with increasing temperature and did not show a minimum corresponding to the peak found in the tensile strength at approximately 4500°F. The creep rate was lower when stress was applied parallel rather than perpendicular to the grain. Total elongations greater than 5% caused decreases in density. Elongations up to 40% and density decreases up to 18% occurred during tensile creep testing. For one grade of extruded graphite, plastic Poisson ratios of 0.18 for the stress perpendicular to the grain and 0.12 for the stress parallel to the grain were found. Activation energies of 170 to 240 kcal/mole were obtained using the rate-process-theory expression  $\dot{\epsilon} = Ae^{-\Delta H/RT}$ , and the time-compensated-temperature expression  $T(C + \log t) = \text{constant}$ . For some test procedures, values as low as 130 kcal/mole were found. (auth)

**3796** NP-8094

Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy.

THE TRANSFORMATION CHARACTERISTICS OF A BETA-PHASE TITANIUM ALLOY. Technical Report No. 3 [on] PHYSICAL METALLURGY OF TITANIUM ALLOYS. R. A. Rawe, J. M. Dupouy, and M. B. Bever. Nov. 20, 1959. 21p. Contract Nonr-1841(02).

The transformation behavior of a titanium alloy containing 11% chromium, 13% vanadium, and 4% aluminum was

investigated by hardness measurements, x ray diffraction and metallography. The solution treated alloy consisted entirely of beta phase. Aging at temperatures between 700 and 1150°F increased the hardness; the rates of hardening suggested that beta decomposed by different modes upon aging above 1050 and below 900°F and by a combination of these modes between these temperatures. X-ray-diffraction analysis indicated that in the upper-temperature range the reactions  $\beta \rightarrow \beta_r + \alpha \rightarrow \beta_u + \alpha + \text{TiCr}_2$  occurred, while in the low-temperature range, the transition phase omega appeared and the reactions were  $\beta \rightarrow \beta_r + \omega \rightarrow \beta_u + \alpha$ . Two modes of decomposition were also suggested by the microstructures. A TTT diagram is proposed on the basis of these results. The hardening is attributed to the precipitation of omega and alpha and to solid solution hardening of the remaining beta. An increase in solution time did not change the hardness of the solution treated specimens but decreased the rate of subsequent hardening. Cold working of solution treated specimens accelerated hardening and raised the hardness level attained. (auth)

**3797** WADC-TR-57-666(Pt. II)

Research Chemicals, Inc., Burbank, Calif. SELECTION AND EVALUATION OF RARE OR UNUSUAL METALS. PART II. THE METALLURGY OF YTTRIUM AND THE RARE EARTH METALS. Period covered: October 1957 to October 1958. Bernard Love. Oct. 31, 1958. 188p. Project title: METALLIC MATERIALS. Task title: UNIQUE METALLIC MATERIALS AND PROCESSES. Contract AF33(616)-5905. (AD-211847; PB-151825). OTS.

Studies were made of yttrium and the rare-earth metals and of alloys of titanium and beryllium with rare-earth additions. Improved methods for the production of pure metals are described. A complete metallographic procedure has been developed. Procedures for the chemical and spectrographic analysis of metals and alloys are provided including a method for oxygen analysis. The rate of moisture absorption of rare-earth oxides was determined under controlled temperature and humidity conditions. Atmospheric corrosion of the metals in dry air was investigated to 600°C and in humid air to 95°C. The methods of preparation, analysis, and examination of titanium and beryllium alloys containing up to 10% rare-earth elements are presented. Tentative partial constitutional diagrams are constructed. Very low solubility was found except for lanthanum which had an indicated solubility between 0.2 and 1.5 wt. %. (auth)

**3798** WADC-TR-59-261

Douglas Aircraft Co., Inc., Long Beach, Calif. INFLUENCE OF SURFACE ON CERAMIC MECHANICAL PROPERTIES. [Period covered]: June 1958 to June 1959. George R. Pulliam. June 1, 1959. 30p. Project Nos. 7021 and 7350. Contract AF33(616)-5875. OTS.

This study was devoted to establishing the importance of gaseous and liquid environments, electromagnetic irradiation, and nonstoichiometry on the deformation and fracture processes in ceramic materials. The surface condition of the material and its chemical environment have been found to have a large effect on these processes. The small ductility of magnesium oxide is reduced by air and basic solutions. Acid solutions produce ductility in previously brittle magnesium oxide. Exclusion of air by a protective coating on a protective atmosphere preserves the ductility. Photochemical reactions essentially stop the creep of silver chloride. A more quantitative evaluation of these effects should be conducted to permit the establishment of the mechanisms operating. (auth)

## 3799

CRYSTALLOGRAPHIC DATA: LITHIUM. M. R. Nadler and Charles P. Kempter (Los Alamos Scientific Lab., N. Mex.). *Anal. Chem.* **31**, 2109(1959) Dec.

X-ray-diffraction studies were performed on lithium. The lattice constant, determined from  $\text{CoK}\alpha_1$  (222) and  $\text{CoK}\alpha_2$  (321) lines, was  $3.51004 \pm 0.00041 \text{ \AA}$  at  $25^\circ\text{C}$ . Theoretical density was determined to be  $0.533 \text{ g/cc}$  and the Li-Li bond density for coordination number 8 is  $3.0398 \text{ \AA}$ . (C.J.G.)

## 3800

STRUCTURE OF THE PLANES IN THE Co-Ti SYSTEM. Hervé Bibring and Jack Manenc (Laboratoires de l'O.N.E.R.A., Châtillon, France). *Compt. rend.* **249**, 1508-10(1959) Oct. 19. (In French)

The cobalt-rich side of the equilibrium diagram of the Co-Ti system was studied by micrography, dilatometry, and x-ray diffraction. The results showed that the allotropic transformation of the solid solution to the  $\beta$  phase is caused by work-hardening if the metal is first brought to the equilibrium state and if the degree of work-hardening is high. The parameters of the  $\gamma$  phase, with a face-centered cubic structure, are little different from the solid solution. The visible precipitation is preceded by a precipitation appearing in the diffraction diagrams as satellite rays. (J.S.R.)

## 3801

MICROGRAPHIC RELATIONSHIPS BETWEEN THE WORK-HARDENED STATE OF ALUMINUM SINGLE CRYSTALS AND THE POLYGONIZED STATE AFTER ANNEALING. Robert Daumas and Jean Montuelle (Laboratoire de Vitry du C.N.R.S., [Paris]). *Compt. rend.* **249**, 1511-13(1959) Oct. 19. (In French)

A systematic examination, as a function of the crystallographic orientation, was made of the polygonization produced in aluminum monocrystals by a stress below a critical degree. The 5% work-hardening was followed by an anneal at  $630^\circ$  for 12 hr. The crystals in which the stress axis is around the (011) pole are deformed under the action of a single slip system, and fold bands are produced. The crystals in which the axis of stress is around the (011)-(111) symmetry zone are deformed simultaneously under two slip systems. The deformation is more homogeneous. (J.S.R.)

## 3802

CONTRIBUTION TO THE STUDY OF URANIUM ALLOYS BY HIGH VACUUM DIFFERENTIAL THERMAL ANALYSIS. J. Bellot, J. M. Henry, and G. Cabane (Centre d'Etudes nucléaires, Saclay, France). *Mem. sci. rev. mét.* **56**, 301-6(1959) Aug. (In French)

The design of an apparatus for the high temperature thermal analysis of alloys is described. The device was used to define the structural transformation temperatures of U-Al, U-Fe, U-Zr, and U-Mo. (J.S.R.)

## 3803

SYNTHESIS OF MULTICOMPONENT SOLID TITANIUM SOLUTIONS. I. I. Kornilov (Baikov Inst. of Metallurgy, Academy of Sciences, USSR). *Doklady Akad. Nauk S.S.S.R.* **128**, 722-5(1959) Oct. 1. (In Russian)

Metallochemical studies are made of diffusion of various elements in titanium solid solutions and typical constitution diagrams for binary and ternary titanium systems are plotted. (R.V.J.)

## 3804

THE INFLUENCE OF THE ADDED ELEMENT ON THE RESISTANCE TO CORROSION AND ELECTRO-CHEMICAL BEHAVIOR OF ALLOYED TITANIUM. V. V. Andreeva and

V. I. Kazarin (Inst. of Physical Chemistry, Academy of Sciences, USSR). *Doklady Akad. Nauk S.S.S.R.* **128**, 748-51(1959) Oct. 1. (In Russian)

The influence of alloying admixtures of B, Al, Cr, Cu, Fe, Mn, Mo, Nb, Ni, Si, Ta, V, and Zr on corrosion and electrochemical behavior of titanium and the mechanism of their protective action were investigated. (R.V.J.)

## 3805

MATERIALS FOR ENVIRONMENTAL EXTREMES. 1. TOMORROW'S ENVIRONMENTAL EXTREMES. 2. ENVIRONMENTAL LIMITS OF MATERIALS. 3. COMPATIBILITY OF MATERIALS. 4. MATERIALS DEVELOPMENT NEEDS. George Sideris. *Electronics* **32**, No. 49, 81-96(1959) Dec. 4.

Radiation effects on properties of materials at  $350$  to  $500^\circ\text{C}$  are discussed. The compatibility of metals and plastics at these temperatures is analyzed. The endurance limits and property changes of structural metals, conductors, and magnetic materials including components such as transducers, semiconductor devices, capacitors and resistors are discussed. The problems to be encountered in future environmental extremes are discussed. (C.J.G.)

## 3806

ON THE FINE STRUCTURE OF URANIUM CRYSTAL GRAINS. V. V. Ryabkina and B. V. Sharov (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). *Fiz. Metal. i Metalloved.* **7**, 360-2(1959) Mar. (In Russian)

The diffraction and micro-x-ray-diffraction methods were used in uncovering the mosaic property of  $\alpha$ -uranium crystals. (R.V.J.)

## 3807

MEASUREMENTS OF THERMAL CAPACITY OF HEAT RESISTANT STEEL. V. E. Lyusternik (Dzerzhinskii All-Union Inst. of Scientific-Research in Heat-Engineering). *Fiz. Metal. i Metalloved.* **7**, 363-6(1959) Mar. (In Russian)

A method is suggested for accurate, automatic recording of the thermal capacity and thermal effects of various phase transformations of metals at  $800$  to  $900^\circ\text{C}$ . (R.V.J.)

## 3808

COMPOSITION-HEAT RESISTANCE DIAGRAMS OF METAL SYSTEMS. I. I. Kornilov and N. T. Domotenko. *Fiz. Metal. i Metalloved.* **7**, 372-7(1959) Mar. (In Russian)

Regularities in thermal resistance variations along the Ni-Cr system were experimentally determined. It was found that at  $800^\circ\text{C}$  the maximum heat resistance of solid solutions of chromium are considerably higher than that of solid solutions of nickel, while at  $1000^\circ\text{C}$  the situation reverses. (R.V.J.)

## 3809

X-RAY DIFFRACTION STUDIES OF DEFORMATIONS AND BONDING IN CRYSTALLINE LATTICE OF NICKEL BASE SOLID SOLUTIONS. N. I. Noskova and V. A. Pavlov (Inst. of Metal Physics, Academy of Sciences, USSR). *Fiz. Metal. i Metalloved.* **7**, 400-4(1959) Mar. (In Russian)

Statistical and dynamic deformations in nickel alloyed with copper or aluminum and given various heat treatments and plastic deformations were measured. The block structure and second-type deformation are determined. (R.V.J.)

## 3810

KINETICS OF Ni-Cr ALLOY SOFTENING. M. P. Arbuzov and M. P. Krulikovskaya (Inst. of Aeronautics). *Fiz. Metal. i Metalloved.* **7**, 432-7(1959) Mar. (In Russian)

Kinetics of Ni-Cr (3.87, 7.65, and 14.43% Cr) softening under cold plastic deformation was studied. Variation curves for the second type  $\Delta a/a$  lattice deformation, the



block dimensions of D mosaic, and hardness in relation to the heating time at 550, 600, 650, and 700° are plotted. (R.V.J.)

### 3811

EFFECTS OF AL AND TI ON THE SOFTENING OF NICHROME ALLOYS. M. P. Arbuzov and V. G. Chernyl. *Fiz. Metal. i Metalloved.* **7**, 438-42 (1959) Mar. (In Russian)

The influence of aluminum and titanium on changes in the crystalline lattice and mechanical properties of nickel-chromium alloys was studied with specimens of Al-Cr-Ni, Cr-Ni-Ti, and Al-Cr-Ni-Ti alloys at 400 to 800°C. (R.V.J.)

### 3812

HEAT CAPACITY OF SAMARIUM FROM 13 to 350°K. L. D. Jennings, Emma D. Hill, and F. H. Spedding (Iowa State Coll., Ames). *J. Chem. Phys.* **31**, 1240-3 (1959) Nov.

Samarium shows anomalies in its heat capacity near 13 and at 105.8°K. The former has already been shown to be magnetic in origin; it appears certain that the latter is also, although there is only a slight sign of an anomaly in the magnetic data near 105°. The magnetic ordering does not appear to be explicable on the assumption of an isotropic S-S coupling mechanism. The thermodynamic functions are tabulated for the temperature region studied. (auth)

### 3813

THE SOLUBILITIES OF NIOBIUM, CERIUM, AND STRONTIUM IN LIQUID BISMUTH. R. J. Pleasance (National Physical Lab., Teddington, Eng.). *J. Inst. Metals* **88**, 45-8 (1959) Sept.

The solubility of niobium in liquid bismuth is shown to be very low, with no indication of the formation of intermetallic compounds. The equilibrium diagram of the bismuth-cerium system was determined up to 17.5 wt.% cerium and that of the bismuth-strontium system up to 12.5 wt.% strontium. Evidence is given that the first intermetallic compounds to form are Bi<sub>3</sub>Ce and Bi<sub>3</sub>Sr, respectively. No indication of a eutectic was found at the bismuth end of the bismuth-cerium system, but a eutectic occurs at about 0.2% strontium in the bismuth-strontium system. (auth)

### 3814

X-RAY ANALYSES OF THE SOLID PHASES IN THE SYSTEM LiF-ThF<sub>4</sub>. L. A. Harris, G. D. White, and R. E. Thoma (Oak Ridge National Lab., Tenn.). *J. Phys. Chem.* **63**, 1974-5 (1959) Nov.

X-ray examination of the crystalline phases in the lithium fluoride-thorium fluoride system and the analyses of their structure are reported. (J.E.D.)

### 3815

PHASE EQUILIBRIA OF THE BINARY SYSTEM PuCl<sub>3</sub>-KCl. Robert Benz and J. A. Leary (Los Alamos Scientific Lab., N. Mex.) and Milton Kahn (Univ. of New Mexico, Albuquerque). *J. Phys. Chem.* **63**, 1983-4 (1959) Nov.

The results of an analysis of cooling curves for PuCl<sub>3</sub>-KCl solution at various compositions are reported. (auth)

### 3816

INFLUENCE OF THE MODE OF PLASTIC DEFORMATION ON THE RECRYSTALLIZATION, AFTER COLD WORKING, OF IMPERFECT SINGLE CRYSTALS OF URANIUM PRODUCED BY  $\beta \rightarrow \alpha$  TRANSFORMATION. D. Calais, P. Lacombe, and N. Simenel (l'Ecole des Mines, Paris). *Mem. sci. rev. mét.* **56**, 261-72 (1959) Aug. (In French)

A new method for the preparation of perfect crystals of

uranium was developed. It is based on a stress deformation of the imperfect crystals from the  $\beta \rightarrow \alpha$  phase transformation, followed by a high temperature anneal above the  $\alpha$  phase. Depending on the orientation of the original crystal, deformation occurs by slip, twinning, or deformation bands. Annealing gives perfect recrystallization crystals, whose orientation has a direct relationship with that of the original crystals. During the recrystallization there are some crystallographic characteristics of the deformation mechanism. The (0 0 1), which is the rotation axis allowing the formation of the deformation bands, is preserved during recrystallization. In the case of deformation by twinning, the recrystallized grains show less clearly marked orientation relationships, but the growth of larger crystals is facilitated. (tr-auth)

### 3817

CONTRIBUTION TO THE STUDY OF THE SOLIDIFICATION OF ALLOYS. André Kohn and Jean Philibert (Institut de Recherches de la Sidérurgie, [France]). *Compt. rend.* **249**, 2073-5 (1959) Nov. 16. (In French)

The combined use of autoradiography, electron-probe microanalysis, and thermal analysis on Al-Cu alloys permitted the mechanism of solidification to be defined. The major part of this phenomenon is effected by the growth at almost constant temperature of crystals of uniform composition. The interdendrite liquid is then solidified over a wide temperature interval. (tr-auth)

### 3818

STUDY OF THE  $\alpha \rightleftharpoons \beta$  ALLOTROPIC TRANSFORMATION OF ZIRCONIUM. J. P. Langeron and P. Lehr (Centre National de la Recherche Scientifique, [Paris]). *Mem. sci. rev. mét.* **56**, 307-15 (1959) Aug. (In French)

The allotropic transformations of zirconium are analyzed, and the crystallographic orientation relationships between the crystals of the  $\alpha$  and  $\beta$  phases are established. The surface roughening observed after transformation must be interpreted as the result of the shear mechanism. The phase change is also accompanied by diffusion and precipitation of certain impurities, particularly iron. The transformation of zirconium belongs to the bainitic type. (tr-auth)

### 3819

THE HARDENING OF MAGNESIUM ALLOYS WITH ZIRCONIUM BY HEATING IN HYDROGEN. J. Hérenghuel and J. Boghen. *Mem. sci. rev. mét.* **56**, 371-8 (1959) Sept. (In French)

A wrought magnesium alloy containing 0.6% Zr was subjected to comparative heat treatments in CO<sub>2</sub> and hydrogen. In CO<sub>2</sub> the grain is relatively stable, and grows slowly with increased time and temperature. The protective effect of CO<sub>2</sub> against oxidation was noted. In hydrogen the grain growth is inhibited even at very high temperatures, and structural hardening occurs. These two phenomena are connected with the formation of a finely divided hydride which is almost insoluble. Marked surface evaporation, not observed in carbon dioxide, was detected. Similar results are found with zirconium concentration from 0.2 to 0.6% and with zinc additions of 0.1 to 0.9%. The protective effect of carbon dioxide persists even when 10% (by weight) of water vapor or 14% (by volume) of hydrogen is added. Surface evaporation, attack by water vapor, and hardening by internal hydriding do not appear in these mixtures. (tr-auth)

### 3820

ELECTRON MICROSCOPE AND MICRODIFFRACTION EXAMINATION OF THIN SECTIONS OF TITANIUM CONTAINING 7, 10, AND 15% ALUMINUM. A. Saulnier and

M. Croutzelles (Compagnie P  chiney a Chamb  ry, France). Mem. sci. rev. m  t. **56**, 379-87(1959) Sept. (In French)

Thin metallic sections of titanium alloys containing 7, 10, and 15% aluminum were observed directly by the electron microscope using a simple and rapid technique. The examination showed the relationship of the embrittlement of the high-aluminum alloys to the appearance of submicroscopic platelets of an ordered solid solution. The platelets are parallel to the (10 $\bar{1}$ 0) planes of the lattice. (tr-auth)

### 3821

TENSILE TESTS ON ZIRCONIUM SAMPLES. J. Orssaud. Mem. sci. rev. m  t. **56**, 512-16(1959) Oct. (In French)

Tensile tests were made on zirconium cold rolled or rolled at 400  C. After rolling the samples were annealed in vacuo between 400 and 800  C. The tensile strength and the hardness vary in the same manner and, for small degrees of reduction, increase after annealing at about 500  C. The cold-rolled metal has a lower percentage elongation than all other samples. The tensile curve for metal heavily rolled at 400  C and annealed at 500  C shows a plateau at the elastic limit. (tr-auth)

### 3822

RESISTANCE OF VARIOUS STEELS TO CORROSION-PITTING. M. G. Timerbulatov and G. I. Babushkina (Central Scientific Research Inst. of Machine Building). Metalloved. i Termichesk. Obrabotka Metal. No. 8, 5-12(1959) Aug. (In Russian)

Results of various types of heat treatments and plastic deformations of stainless chromium steel and chromium nickel austenite steel show that stainless chromium steel (treated for high strength) exhibits better resistance to corrosion pitting than chromium nickel steel. (R.V.J.)

### 3823

INFLUENCE OF SIGMA-PHASE ON MECHANICAL PROPERTIES OF HEAT-RESISTING STEEL. E. E. Levin, E. M. Plvnik, and P. M. Libman (Polzunov Central Scientific-Research Inst. for Boilers and Turbines). Metalloved. i Termichesk. Obrabotka Metal. No. 9, 17-19 (1959) Sept. (In Russian)

The behavior of the  $\sigma$  phase in steel under high-temperature deformation (0.05% C, 20.36% Cr, 0.86% Mn, 0.80% Mo, 0.50% Nb, 10.5% Ni, 0.52% Si, 0.25% Ti, and 1.45% W) was studied by vacuum metallographic methods. (R.V.J.)

### 3824

EFFECTS OF VANADIUM ALLOYING ON FERRITE PROPERTIES. L. I. Mirkin. Metalloved. i Termichesk. Obrabotka Metal. No. 9, 39-41(1959) Sept. (In Russian)

The effects of high-temperature soaking on the softening process in cold worked vanadium (0.80, 2.13, and 3.23 V) alloyed carbonless ferrites were investigated. (R.V.J.)

### 3825

PHASE TRANSFORMATIONS IN IRON ALLOYS. S. A. Eliseev and B. G. Livshits. Metalloved. i Termichesk. Obrabotka Metal. No. 9, 42-3(1959) Sept. (In Russian)

The effects of heat treatment on electroconductivity, magnetic properties and hardness of single phase iron base alloys were studied. (R.V.J.)

### 3826

THE INFLUENCE OF Cr AND Mn ALLOYING ON THE LOW-CARBON STEEL FRIABILITY. V. G. Savitski  , K. V. Popov, V. F. Zakharov, and G. M. Grigor'ev. Metalloved. i Termichesk. Obrabotka Metal. No. 9, 49-51(1959) Sept. (In Russian)

The influence of high manganese content and chromium admixtures on low carbon steel friability was studied with various steels (0.51% Mn; traces of Cr; 0.53% Mn, 0.91% Cr; 0.96% Mn, traces of Cr; 1.07% Mn and 1.03% Cr). (R.V.J.)

### 3827

REN   41-NEW HIGHER-STRENGTH NICKEL-BASE ALLOY. R. J. Morris (General Electric Co., Cincinnati). Metal Progr. **76**, No. 6, 67-70(1959) Dec.

The nickel-base alloy Ren   41 was found to derive its strength principally from the coherent gamma-prime phase precipitate, Ni<sub>3</sub>(Al, Ti). Ren   is producible in all mill forms and can be welded and forged. The yield strength of Ren   41 was determined at 0 to 1400  F. (C.J.G.)

### 3828

ETCHING URANIUM FOR BRIGHT-FIELD EXAMINATION. W. N. Posey (Du Pont de Nemours & Co., Aiken, S. C.). Metal Progr. **76**, No. 6, 101-2(1959) Dec.

A chemical etchant was developed which will reveal the grain structure of uranium under bright-field illumination. The etchant is composed of 130 ml H<sub>2</sub>SO<sub>4</sub> (conc), 50 ml H<sub>2</sub>O (30 wt.%), 0.2 NaSiF<sub>6</sub>, and 60 ml water. The specimen should be immersed in the etchant immediately after the H<sub>2</sub>SO<sub>4</sub> is added. Etching time is approximately 30 sec. (C.J.G.)

### 3829

AN AGE HARDENING TITANIUM ALLOY. V. C. Petersen, H. B. Bomberger, and M. B. Vordahl (Crucible Steel Co. of America, Midland, Penna.) Metal Progr. **76**, No. 6, 119-22 (1959) Dec.

A description is given of a titanium alloy containing 13% V, 11% Cr, and 3% Al which remains 100% in the beta phase as it solidifies and cools to room temperature. It can be age hardened by heating at 850 to 950  F. The properties of the alloy after milling are given. (C.J.G.)

### 3830

SOME ASPECTS OF DIFFUSION IN AN ORDERED ALLOY. Paolo Camagni (Comitato Nazionale Ricerche Nucleari, Ispra, Italy). Studia Ghisleriana Ser. IV, **2**, 239-60(1959) (In Italian)

Some aspects of diffusion in an ordered alloy are reviewed with reference to the typical case of  $\beta$ -brass. Certain general questions concerning the kinetics of atomic movements in an ordered structure of type AB are first considered. This is followed by a review and discussion of experimental data. Lastly, an attempt is made to interpret the results of self-diffusion in the ordered  $\beta$ -brass, on the basis of a strictly configurational model. The conclusions are compared with those to be expected from "classical" theories. (auth)

### 3831

THERMODYNAMIC PROPERTIES OF LIQUID LEAD AND TIN ALLOYS. G. F. Voronin and A. M. Evseev. Zhur. Fiz. Khim. **33**, 2245-8(1959). (In Russian)

The thermodynamic properties of liquid lead-tin alloys were studied over the temperature range 730 to 790  C by the effusion method using a continuous weighing spring balance. The volatile component was lead. The activity of the latter in the alloys was found from the ratio of the rate of compression of the spring balance on vaporization from the alloy and from pure lead. Based on the similarity in shape of the curves for the heat of mixing and of analogous curves for solid alloys it was inferred that the lead-tin alloys in the liquid state possess a microheterogeneous structure. (auth)

### 3832

ON THE USE OF GLASS AS ELECTROLYTE IN STUDIES



OF THE THERMODYNAMIC PROPERTIES OF SODIUM ALLOYS. M. F. Lantratov and A. G. Morachevskii. *Zhur. Fiz. Khim.* 33, 2338-44(1959). (In Russian)

Various types of glass were used as electrolyte to study the thermodynamic properties of liquid sodium alloys by measuring the electromotive force of the concentration cells: Na |electrolyte containing Na ions| Na alloy. It was experimentally shown that the emf of the alloy is independent of the composition and nature of the glass. Substitution of sodium borate glass which did not contain  $\text{SiO}_2$  for silicate was found to have no effect on the value of the emf. (auth)

## Radiation Effects

3833 CF-59-3-33

Oak Ridge National Lab., Tenn.

POST-IRRADIATION EXAMINATION OF APPR FUEL ELEMENT IRRADIATION PROGRAM SPECIMENS. A. E. Richt. Mar. 9, 1959. 29p. OTS.

APPR-type dispersion fuel element specimens containing 17.9, 22.2, and 25.8 wt.%  $\text{UO}_2$  have been irradiated at low temperature to respective burnups of approximately 50, 20, and 20% of uranium with no evidence of gross dimensional changes or loss of structural integrity. Blistering and/or core cracking has occurred when sections of 17.9 wt.%  $\text{UO}_2$  specimens irradiated to burnups over 40% of uranium were subjected to post-irradiation annealing at 600°F for 24 hours. Post-irradiation core hardness measurements indicate that significant differences in irradiation damage exist between the various specimen types. These data indicate that the effects of the fabrication variables investigated in this program are as follows: The severity of irradiation damage in dispersion type fuel elements is inversely proportional to the  $\text{UO}_2$  particle size of the fabricated plate. The particle size of the  $\text{UO}_2$  powder used in preparation of the initial core compact and the method of preparation of the  $\text{UO}_2$  powders largely determine the final  $\text{UO}_2$  particle size of roll-bonded, dispersion fuel plates. The particle size of the stainless steel powder used in the initial core mixture and the degree of cold reduction during final sizing of the fuel plate are apparently of relatively minor importance, at least for the systems investigated in this program. The severity of irradiation damage is directly proportional to the fuel concentration. Where an increased fuel loading is accompanied by an increase in the loading of the  $\text{B}_4\text{C}$  burnable poison to facilitate reactor control, the possibility of serious irradiation effects is increased to an even greater degree. (auth)

3834 NAA-SR-4301

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

ATOMISTIC INTERPRETATION OF RADIATION EFFECTS IN METALS. A. Sosin. Dec. 1, 1959. 34p. Contract AT-11-1-GEN-8. OTS.

The present status of atomistic interpretations of radiation damage in metals is reviewed. Detailed consideration is given to radiation effects and associated lattice defect phenomena in copper, since copper has received the most extensive experimental and theoretical study. The various mechanisms of defect production are presented and models for point defect recovery are considered. The case of radiation-hardening is then concluded to be principally due to more extended radiation-induced defects such as displacement spikes. Finally a particular radiation damage problem, fuel swelling, is discussed with emphasis on its lattice defect implications. (auth)

3835 NP-8095

Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio.

MONTHLY ACCESSION LIST 29 [ON RADIATION EFFECTS DATA]. Nov. 15, 1959. 24p. Project No. 2133. Contract AF33(616)-6564.

3836 NYO-2382

Bausch and Lomb Optical Co., Rochester, N. Y. IRRADIATION DAMAGE TO GLASS. Norbert J. Kreidl and J. Raymond Hensler. Nov. 25, 1959. 42p. Contract AT(30-1)-1312. OTS.

Research directed toward establishing the influence of Al and Li impurities on the radioinduced absorption and thermoluminescence of fused silica is summarized. The results showed that in order to be effective in producing color centers, Al must be located in a Si substituting position in the Si-O network. Exploratory experiments with transition elements in fused silica showed that the thermoluminescence intensity was much greater than that in the Al-Li doped fused silica. Other activities in the field of radiation outside the contract are reported briefly in appendices. (J.R.D.)

3837 REIC-9

Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio.

THE EFFECTS OF NUCLEAR RADIATION ON SILICONE ELASTOMERIC AND PLASTIC MATERIALS. Ramona Mayer, N. J. Broadway, and S. Palinchak. Oct. 15, 1959. 105p. Project No. 2133. Contract AF33(616)-6564.

The state of the art on the effects of nuclear radiation on silicone elastomeric and plastic materials from 1952 to 1959 is reviewed. The radiation-effects information on the various silicone elastomers and plastics and products made from these materials is summarized. Information on radiation effects on silicone fuels and lubricants was not included. The report is intended to be sufficiently inclusive to make it valuable as a guide on effects which can be anticipated from nuclear radiation on silicone elastomers and plastics. (auth)

3838

THE EFFECT OF NEUTRON IRRADIATION ON THE SUPERCONDUCTIVE PROPERTIES OF RHENIUM. Jacques Doulat, Bruce Bailey Goodman, Michel Renard, and Louis Weil (Université, Grenoble, France and Centre d'Etudes nucléaires, Grenoble, France). *Compt. rend.* 249, 2017-19(1959) Nov. 16. (In French)

The study of the effect of neutron irradiation on the superconductivity properties of rhenium has shown a deformation of the  $H_c$ -T curve and a progressive evolution of magnetic properties toward the behavior characteristic of a poorly crystallized superconductor. This last effect is attributed to the production strongly disturbed regions in the sample. (tr-auth)

## PHYSICS

### General and Miscellaneous

3839 AD-154573

Brown Univ., Providence.

ON THE STEADY CREEP OF SHELLS. Technical Report No. 5. E. T. Onat and H. Yuksel. Jan. 1958. 19p. Contract Nonr-562(20)/5.

A modified creep law which is particularly suitable for the investigation of rotationally symmetrical deformations of shells is discussed in detail. It is then applied to es-

tablish the creep behavior of cylindrical sandwich shells in terms of the stress resultants and deflection rates. The creep deflections of simply supported shells under the hydrostatic pressure are discussed as an example. Finite deflections of a solid circular membrane under uniform pressure are also discussed as further examples of the modified creep law. (auth)

**3840** AECU-4483

Martin Co. Nuclear Div., Baltimore.

DIRECT CONVERSION APPLIED TO NUCLEAR HEAT SOURCES. Melvin Barmat. June 19, 1959. 58p. OTS.

Direct conversion techniques appear to offer the best solution to applications where a low or moderate power source of small size, low weight, and long life is required. Some of the fundamentals of engineering nuclear heat sources and heat-to-electricity conversion devices are presented. Construction and performance details of existing devices are given, along with descriptions of some proposed designs. (W.D.M.)

**3841** AERE-M-503

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

SPECTRUM CALCULATIONS IN NON-ABSORBING MEDIA USING KOTTWITZ'S METHOD. E. J. Fowler and R. J. Royston. Aug. 1959. 14p. BIS.

Kottwitz has developed a method of calculating the space- and energy-variation of the thermal neutron flux in an infinite non-absorbing moderator with a temperature discontinuity. The method was used to compute the thermal neutron spectrum at the interface between two semi-infinite graphite regions at different temperatures. The effect of the departure of the spectrum from Maxwellian was studied by calculating the reaction rates in a  $1/v$  absorber and in  $\text{Pu}^{239}$ . (auth)

**3842** AERE-R-2977

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

THE OPTICAL SPECTRA OF SOME RARE EARTH AND TRANSURANIC ELEMENTS IN THE 1-3 MICRON REGION. PART II. WAVELENGTH MEASUREMENT AND THE SPECTRUM OF PLUTONIUM ( $\text{Pu}^{239}$ ). L. Bovey, E. B. M. Steers, and N. Atherton. Oct. 1959. 15p. BIS.

The method for the measurement and comparison of the wavelengths of the plutonium lines in the 1 to  $3 \mu$  region ( $10,000$  to  $3,300 \text{ cm}^{-1}$ ) are given together with an indication of the experimental accuracy. A list of the wavelengths and intensities for plutonium lines is included. (auth)

**3843** AFOSR-TN-59-895

Pomona Coll., Claremont, Calif. Millikan Lab. of Physics. ULTRASOFT X-RAY INTERACTION COEFFICIENTS. Technical Report No. 3. Burton L. Henke and Jack C. Miller. Aug. 1959. Includes Reprint: SEMIEMPIRICAL DETERMINATION OF MASS ABSORPTION COEFFICIENTS FOR THE 5 TO 50 ANGSTROM X-RAY REGION. Burton L. Henke, Richard White, and Bruno Lundberg. *J. Appl. Phys.* 28, 98-105(1957). 84p. Contract AF49(638)-394.

Photoelectric cross-sections may be interpolated from universal absorption functions and used to deduce the transitional probabilities for a particular atom which in turn allow the evaluation of the quantum dispersion equations for the atomic scattering factors. Universal tabulated functions were obtained in this manner for the atomic scattering factors. It is noted that this approach is particularly appropriate and precise for the ultrasoft region for which the ratio of the atomic diameters to the

wavelength is very small and thus only dipole interactions are effective. Atomic scattering factors were tabulated for O, Al, and Si; refractive indices were obtained for Al,  $\text{Al}_2\text{O}_3$ , and  $\text{SiO}_2$ ; and the reflected intensities from surfaces of Al,  $\text{Al}_2\text{O}_3$ , and  $\text{SiO}_2$  and from layered combinations of these surfaces were tabulated as a function of both wavelength and angle of reflection. These results were used to illustrate the potentiality of ultrasoft x radiations for application to the microanalysis for mass, chemical, and surface structure. (auth)

**3844** AFOSR-TN-59-927

Cornell Univ., Ithaca, N. Y. Graduate School of Aeronautical Engineering.

AN INVISCID BOUNDARY LAYER OF MAGNETOHYDRODYNAMICS. William S. Lewellen. Sept. 1959. 51p. Contract AF18(600)-1523.

A boundary-layer approximation for fluids with large electrical conductivities is applied to the two-dimensional, steady, inviscid, incompressible magnetohydrodynamic equations for the case of a uniform magnetic field parallel to the free stream. Two approaches to the solution of the magnetic boundary layer are used. In the first, the approximate integral method is used to derive equations analogous to the von Kármán integral momentum equation of viscous theory. These equations are integrated for flow of the type  $\mu_1 = Cx^n$ . In the second approach the exact magnetic-boundary-layer equations are transformed, for similar flows, into a system of ordinary differential equations. The solution of these equations is found in the form of a power series expansion in a parameter equal to the Alfvén speed divided by the freestream velocity. Numerical results are given for several cases of similar flow. In sub-Alfvénic flow, evidence points to a boundary layer growing in the direction opposite to the flow. (auth)

**3845** CF-59-11-2

Oak Ridge National Lab., Tenn.

AN IBM-704 CODE FOR DETERMINING EQUILIBRIUM ORBITS AND PROPERTIES OF SMALL-AMPLITUDE OSCILLATIONS IN CYCLOTRON FIELDS. M. M. Gordon, T. A. Welton, T. I. Arnette, and H. C. Owens. Nov. 17, 1959. 55p. OTS.

An IBM-704 code for calculating properties of equilibrium orbits and small oscillations in general cyclotron magnetic fields is described in detail. The code is very flexible, accurate, and economical to operate. (auth)

**3846** CF-59-11-67

Oak Ridge National Lab., Tenn.

THERMODYNAMIC DIAGRAMS FOR LITHIUM, SODIUM, AND POTASSIUM. L. G. Epel and J. R. Simmons. Nov. 12, 1959. 9p. OTS.

Charts for the thermodynamic properties of lithium, sodium, and potassium in the wet and superheated vapor regions were prepared and are presented to facilitate thermodynamic cycle calculations. (auth)

**3847** CF-59-12-3

Oak Ridge National Lab., Tenn.

A CRYSTALLOGRAPHIC FUNCTION AND ERROR PROGRAM FOR THE IBM-704. William R. Busing and Henri A. Levy. Dec. 9, 1959. 94p. OTS.

Given the unit cell parameters of a crystal together with the atomic coordinates and/or the anisotropic temperature factor coefficients, a program is described which will compute various functions of these parameters such as the distance between two atoms, an angle defined by three atoms, the principal axes of the anisotropic temperature factor, etc. The program will also compute the



standard errors of the various functions with and without the contribution of the cell parameter errors. The various types of functions which can be evaluated are defined by subroutines, fifteen of which are included. (W.D.M.)

### 3848 CNC-18

Italy. Comitato Nazionale per le Ricerche Nucleari.

Divisione Studi e Ricerche, Rome.

IL RALLENTAMENTO DEI NEUTRONI IN UN MEZZO OMOGENEO INFINITO. II. RALLENTAMENTO CON CATTURA COSTANTE. (The Slowing Down of Neutrons in an Infinite Homogeneous Medium. II. Slowing Down with Constant Capture.) V. Boffi. Oct. 1959. 31p.

In the first part of the paper (CNC-14) the problem of neutron slowing down was considered in the absence of capture. In the second part the study is continued by considering the capture process with the hypothesis that the relative probability of capture remains constant. The validity of the asymptotic results for the function  $N(z)$  in the interval from 1 to  $\infty$  of the variable  $z$  is proved. The use of the mathematical formalism adopted in Part I leads to a simple and intuitive treatment of the problem and to results which generalize those obtained by Placzek (*Phys. Rev.* **69**, 432(1946)). (J.S.R.)

### 3849 HW-61042

General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

SYZGY, A CODE FOR CALCULATING THE THERMAL NEUTRON FLUX SPECTRUM NEAR A TEMPERATURE DISCONTINUITY. J. E. Schlosser. Aug. 14, 1959. 53p. Contract AT(45-1)-1350. OTS.

The machine program SYZGY computes the thermal neutron flux spectrum and total neutron density near a temperature discontinuity using a nonabsorbing heavy gas approximation. Three system geometries are included as follows: (a) an infinite plane separating media at temperatures  $T_1$  and  $T_2$ , (b) an infinite slab at temperature  $T_1$  embedded in an infinite medium at temperature  $T_2$ , and (c) an infinite cylinder at temperature  $T_1$  surrounded by an infinite medium at temperature  $T_2$ . SYZGY was written in FORTRAN for an IBM 709 with a 32 K memory. A description of the program and a discussion of the numerical accuracy obtained are given and a sample problem is included. The FORTRAN source deck listing is included. Input consists of the physical parameters of the media, the temperatures of the media, and numbers giving the position and energy ranges desired. Approximately three minutes are required for a typical case. (auth)

### 3850 KAPL-M-MCR-1

Knolls Atomic Power Lab., Schenectady, N. Y. CALCULATION OF FREQUENCIES AND MODE SHAPES FOR MULTI-DEGREE OF FREEDOM SYSTEMS USING THE IBM 650 COMPUTER. Mary C. Ray. Nov. 25, 1959. 39p. Contract W-31-109-Eng-52. OTS.

A means of computing the normal mode shapes and frequencies for structure response to applied load is presented. The computation can be done by the IBM 650 magnetic drum data-processing machine. With the mass and influence coefficient (flexibility) matrices as input, the machine computes all the frequencies and mode shapes; these are the eigenvalues and eigenvectors. Limitations of the method are discussed and examples to show code operation are given. (J.R.D.)

### 3851 LA-2355

Los Alamos Scientific Lab., N. Mex.

DOSE AND FLUX MEASUREMENTS ON GODIVA RADIATION EFFECTS EXPERIMENTS. Payne S. Harris,

E. Frank Montoya, and William H. Schweitzer. Sept. 21, 1959. 19p. Contract W-7405-eng-36. OTS.

Flux and dose measurements of fast neutrons, thermal neutrons, and gamma rays under perturbing conditions using Godiva as a source are described and discussed. The limitations of single monitoring devices are noted. It is pointed out that in order to improve the accuracy of flux and dose measurements in radiation effects studies, specific detectors must be used at the position of the experimental object. (auth)

### 3852 NAA-SR-4058

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

CONVERGENCE OF THE  $S_N$  METHOD FOR THERMAL SYSTEMS. E. Blue and H. P. Flatt. Nov. 1, 1959. 45p. Contract AT-11-1-GEN-8. OTS.

It has been observed in the past that the computer time required for the numerical solution of the transport equation has been almost prohibitive for many problems of interest. Results of a study designed to improve the convergence rate of the angular segmentation or  $S_N$  method are presented. Examples showing the effect of several different modifications of the standard  $S_N$  method are given. It is concluded that the incorporation of the modification discussed will significantly accelerate the convergence of the  $S_N$  method and permit an efficient solution of many problems related to thermal assemblies. (auth)

### 3853 NAA-SR-4351

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

PERTURBATION THEORY AND REACTOR ANALYSIS. E. Blue and J. W. Zink. Nov. 15, 1959. 15p. Contract AT-11-1-GEN-8. OTS.

Approximate solutions to many problems of interest in reactor design are often obtained by means of first-order perturbation theory. The utility of such calculations is assessed herein, and it is observed that higher-order calculations are essential to meaningful results. A method which has the virtue of rapid convergence and simplicity of form, is chosen from among many of the well known methods. This method is employed to illustrate both the need for second-order answers and the improved convergence of the solution of a typical one-group reactor problem. A procedure is presented which allows multi-group calculations to be carried out by means of this theory. (auth)

### 3854 NP-8072

Columbia Univ., New York. Columbia Radiation Lab. RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM. Quarterly Progress Report No. 7 for June 16, 1959 through September 15, 1959. P. Kusach. Sept. 15, 1959. 61p. Contract DA-36-039-SC-73279. (CU-9-59-SC-73279-Phys.).

The inauguration of a new series of experiments on harmonic generation in magnetrons, with the ultimate hope of magnetron generation of power in a previously unattainable frequency range is reported. Progress in other magnetron work is also described. A detailed discussion of several major maser projects is given; in particular the results of radioastronomic measurements with the use of maser amplifiers are reported. The conclusions of a detailed study of the properties of sources for gas masers are presented. A detailed theoretical and experimental study of microwave resonators made of high dielectric materials is described; it appears that such resonators may have important applications. A number of projects dealing with spectroscopy

by the methods of microwave spectroscopy and atomic beams are described. Progress in studies of various properties of atomic and molecular systems is reported. (See also NP-7572.) (auth)

### 3855 NP-8086

Naval Research Lab., Washington, D. C.  
NRL QUARTERLY ON NUCLEAR SCIENCE AND TECHNOLOGY. Progress Report [for] July-September 1959. Oct. 1, 1959. 31p.

The reaction  $O^{18}(He^3,n)Ne^{18}$  was used to determine the ground-state mass of  $Ne^{18}$ , to search for excited states, and to measure the half life of the positron activity associated with the decay of  $Ne^{18}$ . An absolute measurement of the  $(d,n)$  threshold energy for the target nucleus,  $O^{16}$ , was made. An approach to a high-efficiency, long-lived vacuum cold trap is described which combines very low-temperature surfaces, high-trapping efficiency, high-pumping speed, convenient operation, low operating costs, etc. Some novel concepts are used to obviate some of the usual disadvantages. A technique is described for making reasonably sized, fairly high-density, and long-lived  $CaB_6$  bricks which can be used in building a neutron shield or sink. The alternate mode of decay of the  $\pi^0$ -meson in the  $\pi^- + p \rightarrow n + \pi^0$  reaction, in which one of the photons is virtual and creates an electron-positron pair, was calculated. Preliminary results are given from a 7.5 hr balloon flight at 2.7 gm/cm<sup>2</sup> on the abundance ratio of Li, Be, and B to the heavier nuclei in cosmic radiation. Gamma radiation from eight-day  $Ag^{108}$  is discussed. Correction of the negative-mass instability in circular accelerators is considered. (For preceding period see NP-7841.) (W.D.M.)

### 3856 NP-8087

New York Univ., New York.  
RESEARCH ON SOLID STATE RADIATION-INDUCED PHENOMENA. Quarterly Progress Report No. 6 for May-July 1959. Hartmut Kallmann. Oct. 1959. 80p. Contract DA-36-039-SC-75043.

Energy Transfer in Plastics. The fluorescence emission of PMMA/pyrene is investigated under  $\gamma$ -ray excitation and under direct solute excitation by 3300 Å. The  $\gamma$ -ray induced fluorescence of PS/9,10-dimethoxyanthracene is investigated in the presence and absence of naphthalene as intermediate "solvent." Behavior of Excited Electrons and Holes in Zinc Sulfide Phosphors. The investigation of the behavior of ZnS at low and room temperatures has reached the point where some definite conclusions can be drawn. A review of the entire investigation up to now is given. The deficiency areas of the rise of fluorescence and the respective glow areas are compared under different types of excitation, different activators, and different external conditions. At low temperature a large percentage of the processes which lead to a return of the excited electrons to the ground state are non-radiative during the excitation. During the glow period, however, the processes seem to be mostly radiative. Under excitation by fast electrons of Cu activated phosphors, non-radiative processes are particularly strong. They are traced back to a non-radiative recombination of holes with trapped electrons. A theoretical discussion of the processes involved is given. Investigation of ZnCdS:Mn Phosphors. The rate of decrease in fluorescence observed with some of the ZnCdS:Mn phosphors in approaching equilibrium was studied as a function of incident radiation. The  $\beta$  and 4340 Å excitations were compared, and it was found that they have an unequal influence on the number of non-radiative transitions which occur as the equilibrium condition is approached. (For preceding period see NP-7750.) (auth)

### 3857 NP-8091

Illinois. Univ., Urbana.  
PHYSICS OF THE SOLID STATE. Technical Report No. 2. Robert J. Maurer. Nov. 1959. 15p. Contract Nonr 1834(19).

Potassium chloride and potassium bromide crystals were exposed to x rays at 10°K. The optical absorption produced by this irradiation and the changes in optical absorption produced by subsequent annealing at higher temperatures were measured. The temperatures at which changes in optical absorption occurred were correlated with the temperatures at which free electrical charge appeared, and thermoluminescence was observed. The absorption band at 345 mμ, in KCl, which has been named the H band, was shown to possess a component caused by self-trapped holes. In KCl, the self-trapped hole band bleaches thermally at 43°K with a release of free electrical charge. H centers disappear at 56°K with a release of free charge. The optical absorption band of the H center was shown to have its maximum at 335 mμ. In KBr, the thermal release of free charge at 30°K is attributed to the disappearance of H centers. No charge burst was observed in KBr which may be attributed to the destruction of self-trapped holes. (auth)

### 3858 NP-8092

Illinois. Univ., Urbana.  
TRANSPORT NUMBER IN SOLID CESIUM BROMIDE. Technical Report No. 3 [on] PHYSICS OF THE SOLID STATE. Neal Laurance. Nov. 1959. 10p. Contract Nonr-1834(19).

The transport number of cesium bromide single crystals was measured over the temperature range 350 to 450°C by the method of Tubandt. No temperature dependence is observed, and the average value of the cation transport number is  $0.49 \pm 0.05$ . A preferential growth phenomenon is described, and its possible interference with the measurement is discussed. It is estimated that the true cation transport number may be as low as 0.3 because of this phenomenon. (auth)

### 3859 NP-8099

Maryland. Univ., College Park.  
QUASI-PARTICLE APPROACH TO INTERACTION IN AN IDEALIZED METAL. Technical Report No. 156. John J. Quinn and Richard A. Ferrell. Sept. 1959. 25p. Contract AF49(638)399.

The properties of a degenerate electron gas with a background of positive charge capable of propagating phonons are studied by means of a quasi-particle approach. The ground state of the system is pictured as a "vacuum" state, and any additional particles or holes together with their polarization clouds are thought of as quasi-particles. The Coulomb repulsion and the effective electron-electron attraction due to phonon exchange are treated separately. The specific heat, spin susceptibility, and compressibility are determined in terms of the effective energy of interaction  $V_{pp'}$  of two quasi-particles. Considering only the lowest order process contributing to  $V_{pp'}$  reproduces known results for the high density limit Coulomb correction to the specific heat and spin susceptibility, but gives a new result for the phonon correction. To lowest order it is found that the electron-phonon interaction produces no change in the spin susceptibility, in contrast to general expectation. For real metallic densities higher order graphs must be included, however for this case it may be possible to choose  $V_{pp'}$  empirically. (auth)

### 3860 NP-8101

Massachusetts Inst. of Tech., Cambridge.  
AN EXPERIMENTAL APPROACH TO THE DETERMINA-



TION OF GASEOUS TRANSPORT PROPERTIES AT VERY HIGH TEMPERATURES. Technical Report No. 4.

I. Amdur. Nov. 30, 1959. 21p. Contract Nonr 1841(23).

Values of gaseous transport properties at elevated temperatures may be calculated from appropriate kinetic theory relations (or from statistical mechanics if equilibrium properties are of interest) provided that the correct intermolecular potential functions are known. It is pointed out that the potentials for this purpose may not be extrapolations of functions which are valid only for relatively large distances of separation, and therefore suitable only for calculation of low temperature properties, but must be ones which are valid at the smaller distances of separation of importance at elevated temperatures. The experimental procedure is described for determining such potentials from elastic scattering of neutral beam particles having kinetic energies of the order of 1000 ev. It is shown that meaningful potential energy information cannot be deduced from such experiments unless the shape and intensity distribution of the beam, as well as the geometry of the beam-detector system are taken into account. Results are tabulated for the potentials of a number of atom-atom and atom-molecule systems and a procedure for obtaining molecule-molecule interactions from such results is indicated. The procedure is outlined for using appropriate interaction potentials for calculating transport properties over a wide range of temperature and the results are illustrated in terms of the viscosity of xenon between 1000 and 10,000°K. It is shown that the method may be applied to the calculation of properties of mixtures which require potentials between unlike particles. The criterion is given for determining the range of temperature over which all such calculations are valid, namely, that it is the magnitude of the fraction of the kinetic energy of the beam particles which is converted into potential energy at the distance of closest approach during a collision and not the kinetic energy itself, which determines the region of validity. Possible experimental procedures are suggested which might be used to obtain intermolecular potentials for binary systems containing ions, dissociative atomic species, metastable, and excited species. (auth)

**3861** ORNL-2801

Oak Ridge National Lab., Tenn.

OBSERVATION OF NONPROPORTIONALITY OF RESPONSE FOR A NaI(Tl) SCINTILLATION CRYSTAL. R. W. Peelle and T. A. Love. Dec. 7, 1959. 9p. Contract W-7405-eng-26. OTS.

By observing "sum" pulse-height distributions which correspond to the simultaneous detection of cascade gamma rays, the nonproportionality of response of a 3-in.-diam. by 3-in. NaI(Tl) crystal was briefly studied in a manner which did not depend critically on the performance of the pulse-height discriminator system. The sum peaks occurred at pulse heights higher than would have been expected on the hypothesis that the integrated light output of the crystal was proportional to the absorbed gamma-ray energy. This difference corresponded to an average of  $(30 \pm 6)$  kev for the experiments performed using the cascade gamma-ray transition of  $Y^{88}$  and  $Bi^{207}$ . (auth)

**3862** ORO-220

Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.

IONIZATION AND CHARGE TRANSFER CROSS SECTIONS. Technical Status Report No. 1 Covering the Period September 1, 1959 to November 30, 1959. E. W. McDaniel, D. W. Martin, J. W. Hooper, and D. S. Harmer. 6p. Project No. B-176. Contract AT(40-1)-2591. OTS.

The objective of the research is the measurement of the cross sections for various ionization and charge transfer reactions of hydrogen atoms and ions incident on targets of hydrogen and helium gas. The energy of the incident particles will range from 0.15 to 1.10 Mev. The source of energetic particles in a 1-Mev Van de Graaff positive ion accelerator, which is equipped with a beam analyzing and stabilizing system. Construction of the collision chamber and vacuum system was completed, and construction of the internal electrode system is proceeding on schedule.

(W.D.M.)

**3863** SCTM-271-59(14)

Sandia Corp., Albuquerque, N. Mex.

THE QUARTER WAVE CYLINDRICAL ANTENNA IN A DISSIPATIVE MEDIUM: CURRENT AND IMPEDANCE. Ronald W. P. King and Charles W. Harrison, Jr. Sept. 1, 1959. 30p. OTS.

An integral equation for the distribution of current along a cylindrical antenna in a conducting dielectric is derived. It is shown that the boundary conditions for an antenna in such a medium are formally the same as for an antenna in free space. The equation is solved for the current  $I$  and the driving-point impedance  $Z$  by means of a technique that achieves sufficiently high accuracy in the leading terms of an iteration procedure so that the higher-order terms do not need to be evaluated. Moreover, these leading terms consist only of trigonometric functions with complex coefficients. The electromagnetic field in the infinite dissipative medium may be computed easily and in closed form since the current in the antenna is expressed in such simple terms. A numerical analysis is made to determine the properties of an antenna with an electrical length of one-half wavelength in the medium with conductivity  $\sigma$  and relative dielectric constant  $\epsilon_r$ . Universal curves are given of  $1/\sqrt{\epsilon_r}$  with  $\sigma/\omega\epsilon_0\epsilon_r$  as the parameter and of  $Z/\sqrt{\epsilon_r}$  with  $\sigma/\omega\epsilon_0\epsilon_r$  as the variable in the range  $0 \leq \sigma/\omega\epsilon_0\epsilon_r \leq 0.4$ . A table of numerical values of the impedance is given for media such as the ionosphere, dry salt, dry earth, wet earth, and lake water. (auth)

**3864** TID-3540

Technical Information Service Extension, AEC.

ISOTOPIC POWER AND THERMIONIC CONVERSION. A Literature Search. Raymond L. Scott, comp. Dec. 1959. 12p. OTS.

This literature search contains 88 references on thermionic conversion of heat energy and the use of radioisotopes as power sources. (W.L.H.)

**3865** UCRL-5644-T

California, Univ., Livermore. Lawrence Radiation Lab.

THERMODYNAMICS OF IRREVERSIBLE PROCESSES: THE EXPERIMENTAL VERIFICATION OF THE ONSAGER RECIPROCAL RELATIONS. Donald G. Miller. July 30, 1959. 81p. Contract W-7405-eng-48. OTS.

In the last twenty years a thermodynamic theory of irreversible processes (TIP) has been vigorously developed which has been able to treat irreversible phenomena in a detailed way. The present macroscopic form of the theory was suggested primarily by the statistical mechanical investigations of Onsager. The presently available experimental data are collected for a variety of quite different irreversible phenomena and it is shown that this evidence does indeed verify the Onsager Reciprocal Relations. Thermoelectricity, electro-kinetics, transference in electrolytic solutions, isothermal diffusion, heat diffusion, heat conduction in anisotropic solids, and thermogalvanomagnetic effects are the phenomena considered in detail. (W.D.M.)

**3866 UCRL-8854**

California, Univ., Berkeley. Lawrence Radiation Lab. MEASUREMENT OF RADIATIVE LIFETIMES. I. AN APPARATUS FOR MEASUREMENT OF MILLIMICROSECOND RADIATIVE LIFETIMES OF GAS-PHASE MOLECULES. II. THE RADIATIVE LIFETIME OF THE  $B\ 0_u^+$  STATE OF  $I_2$  BY TWO ABSOLUTE ABSORPTION METHODS (thesis). Fred Ezra Stafford. APPENDIX: DESCRIPTION OF ELECTRONIC SYSTEM. Jerry M. Sakai and Fred E[zra] Stafford. Sept. 21, 1959. 126p. Contract W-7405-eng-48. OTS.

Knowledge of radiative lifetimes is valuable for application to problems in thermodynamics of high-temperature systems, kinetics of energy transfer, and electronic structure of molecules. Although measurement of these lifetimes involves working with millimicrosecond times and extremely low signal levels, various methods have been developed and are summarized. The instrument described here measures a change in phase produced by the finite time required for fluorescence. Exciting light is 65% modulated at 5.2 Mc by a supersonic grating modulator. The 5.2-Mc fluorescence signal is beat to  $1000 \pm 0.1$  cps, and its phase is measured by the use of calibrated phase shifters and a null-indicating phase detector. The phase detector has a long time constant which causes it to "average out" much of the noise that reaches it. The accuracy and sensibility of the instrument for low-level signals are limited by the phase-detector sensibility of  $\pm 0.5^\circ$ . With the present frequency of modulation, lifetimes between  $6 \times 10^{-8}$  and  $10^{-7}$  sec can be measured within 20%. Measurement of the time-of-flight of light shows that absolute accuracy is within this sensibility. The lifetime of the level of iodine which combines with the ground state to give rise to the visible-band system is determined to be  $5 \times 10^{-7}$  sec  $\pm 20\%$  from measurements of the integrated band absorption. This state has been assigned the designation  $B\ 0_u^+$ . The value  $3 \times 10^{-7}$  sec is obtained from absorption of a single line plus relative intensities of only the first 18 members of the fluorescence series and is much more uncertain. Consideration of the sum rules for transition probability leads to the expectation that variation of electronic-transition probability over the band system is not large, and that the average value obtained from the total band absorption measurements should be valid for  $\nu' = 26$  in particular. However, the lifetime may be up to 30% longer than the value stated because of the energy-cubed dependence of the fluorescence rate and the extension of the fluorescence series far into the red. Various data for vibrational-energy transfer and for quenching of the  $B\ 0_u^+$   $\nu' = 26$ ,  $J' = 34$  level are put on an absolute scale with this lifetime. The cross section for collisions with various gases to produce vibrational transfer to states with  $\nu' = 24, 25$ , or 27 ranges between  $1/3$  and  $1/30$  of the gas kinetic cross section. The cross section for quenching by foreign gases ranges between 1 and  $1/30$ , while that for self-quenching is 3 times the gas kinetic cross section. (auth)

**3867 UCRL-8936**

California, Univ., Berkeley. Lawrence Radiation Lab. PHYSICS DIVISION SEMIANNUAL REPORT, NOVEMBER 1958 THROUGH APRIL 1959. Aug. 1959. 46p. Contract W-7405-eng-48. OTS.

Experiments in progress and research results are briefly summarized in the areas of bubble chambers, K-mesons and hyperons, heavy ions, stopping power of elements, physics of the nucleus, nucleon scattering theory, antinucleons, dispersion relations, decay schemes for elementary particles, cyclotron design studies, plasma problems, atomic physics, mathematics, x rays from K-mesic

atoms, antiproton interactions in  $H_2$  and  $D_2$ ,  $K^-$  interactions in  $D_2$ , cosmic neutrons, production and decay of  $K^0$ -mesons,  $\mu^-$  capture in nuclei, and accelerator operations and development. (For preceding period see UCRL-8545.) (W.D.M.)

**3868 WAPD-TM-125**

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

TUT-T5—A TWO DIMENSIONAL MONTE CARLO CALCULATION OF CAPTURE PROBABILITIES FOR THE IBM-704. J. Spanier, H. Kuehn, and W. Gulinger. Nov. 1959. 39p. Contract AT-11-1-GEN-14. OTS.

The TUT-T5 code calculates, for a one-energy model, a regionwise distribution of capture probabilities in a two-dimensional quarter-cell by a Monte Carlo method. If desired, as many as 32 regions can be treated, all of different material content; however, the content of each region must be uniform. The code also calculates error estimates for each problem. All the information needed to use the code is supplied, and a forthcoming report will present the mathematical analysis for this calculation. (auth)

**3869 AEC-tr-3681**

INVESTIGATION OF THE INSTANTANEOUS BRIGHTNESS OF A FLASH DISCHARGE. F. A. Charnaya. Translated for Los Alamos Scientific Lab. from *Optika i Spektroskopiya* 4, 725-33(1958). 11p. JCL or LC.

The time curve of the brightness spectral density in terms energy from a channel of spherical flash lamps filled with xenon, krypton, argon, oxygen, nitrogen, neon, and helium was investigated in the 0.4 to 1  $\mu$  region. It was found that in all the gases investigated except helium, the maximum instantaneous value of the brightness spectral density rises initially as the energy introduced into the discharge channel is increased and then becomes constant throughout a wide range of parameter changes in the discharge circuit such as changes of voltage across the capacitor, and interelectrode distance. The value of brightness spectra density in terms of energy is inversely proportional to the atomic weight of the gas. (J.R.D.)

**3870 AEC-tr-3683**

STRATIFICATION OF SOLUTIONS OF LIQUID HELIUM ISOTOPES AT VERY LOW TEMPERATURES.

R. Chentsov. Translated for Los Alamos Scientific Lab. from *Uspekhi Fiz. Nauk* 64, 195-6(1958). 3p. JCL or LC.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 12, abstract No. 11575.

**3871 AEC-tr-3899**

THE ULTRAVIOLET YIELD FROM A DISCHARGE TUBE IN AIR. I. Agarbiceanu, N. Stanescu, A. Popa, and I. Vioresanu. Translated for Los Alamos Scientific Lab.

from *Bul. inst. politehnic Bucuresti* 19, No. 2-3(1957). 9p. JCL.

Paper read at the Scientific meeting of the teaching staff of the Bucharest Polytechnic Inst., June 27-28, 1957.

A brief description of the experimental installation, measurement method, and results interpretation for determining the ultraviolet radiation in air electric discharges is presented. The investigation is aimed at improving the ultraviolet yield of continuous hydrogen emission. (J.R.D.)

**3872 ATI-10982**

ELECTRON AND ION EMISSION OF THORIATED TUNGSTEN (Elektronnaya i Ionnaya Emissia Torirovannogo Volframa v Parakh Natriya). L. N. Dobretsov. Translated from *Zhur. Eksptl' i Teoret Fiz.* 17, 301-13(1947). 34p. (Includes original, 19p.)

The electron emission and surface ionization of a tho-



riated tungsten filament was investigated in an atmosphere of sodium vapor over a wide range of vapor densities, for several degrees of activation, at different filament temperatures, and in the presence of different electric fields at the surface of the filament. An explanation of the results obtained, in addition to the well-known information on the properties of thoriated tungsten, necessitates making the assumption that the work function of tungsten increases when sodium is adsorbed on it. (auth)

**3873** CEA-tr-R-519

PASSAGE DE L'ÉTAT ANTIFERROMAGNÉTIQUE À L'ÉTAT FERROMAGNÉTIQUE DANS  $\text{CoSO}_4$ . (Passage from the Antiferromagnetic State to the Ferromagnetic State in  $\text{CoSO}_4$ ). A. S. Borovik-Romanov and N. M. Kreines. Translated into French by I. Melnick from *Zhur. Eksptl. i Teoret. Fiz.* **35**, 1035-55(1958). 5p.

The magnetic properties of  $\text{CoSO}_4$  monocrystals were studied in the temperature interval from 1.3 to 70°K. It was established that the crystals pass to the antiferromagnetic state at about 12°K. The magnetic susceptibility does not depend on the magnetic field up to field values of 4 Oe. When the temperature approaches zero, the susceptibility does not tend toward zero on any of the axes. In a strong field the susceptibility of the length of the *b* and *c* axes is independent of the field up to 18 Oe, but along the *a* axis the magnetic moment increases sharply at 12 Oe. This increase is connected to the reversing of the magnetization vectors of the sub-lattice and to the transition from the antiferromagnetic to the ferromagnetic state. (J.S.R.)

**3874** NP-tr-316

ADSORPTION OF ANOTHER GAS FROM A CURRENT OF AIR. N. A. Shilov, L. K. Lepin', and S. A. Voznesenskii. Translated by D. H. Bolton (U.K.A.E.A., Atomic Energy Research Establishment) from *Zhur. Russ. Fiz.-Khim. Obshchestva* **61**, 1107-23(1929). 54p. (Handwritten MS.). JCL or LC.

The distribution of absorbed and residual gas in a bed of adsorbent after passage of air containing the gas was determined by direct experiment. The distribution was studied as a function of both time and distance with various samples of charcoals, air rates, and chlorine concentrations. A relation was established between the duration of protective action and the length of absorbent layer. Two empirical quantities are proposed for the characterization of the performance of an absorption bed,  $\theta$ , the coefficient of protective action, and  $\tau$  the initial loss of protective action. These quantities enable the calculation of the relation between the length of an absorbent layer and the duration of its protective action in individual cases. (W.L.H.)

**3875** SCL-T-285

THE DISCHARGE FORMS IN THE CYLINDRICAL COUNTING TUBE. (Die Entladungsformen im Zylindrischen Zählrohr). (Excerpts). Sven Werner. Translated by Marcel I. Weinreich (Sandia Corp.) from *Z. Physik* **90**, 384-402(1934). 10p. OTS.

The excerpts include chapters on counting range and unstable corona discharges, stable corona discharges, photo-stabilized corona discharges, limitation of corona discharges, duration of unstable corona discharges, and conclusions. (J.R.D.)

**3876**

MEASUREMENT OF THE MASS OF  $\text{Rn}^{222}$  BY MASS SPECTROGRAPHY. S. Szűcs (Centre de Louvain, Belg.) and J. M. Delfosse (C.P.N.L. Héverlé-Louvain, Belg.). *Ann. soc. sci. Bruxelles, Ser. II*, **73**, 279-86(1959). (In French)

The mass of  $\text{Rn}^{222}$  was measured using nuclear plates sensitive to nucleons emitted by radioactive ions after im-

pact. The  $\text{Rn}^{222}$ - $\text{Pb}^{207}$  doublet ( $\text{CH}_3$ ) was chosen because the  $\alpha$ -emitter is gaseous, short-lived, and the measurement can be compared readily with calculations. A Mat-tauch 360 mm spectrograph with a classic discharge source was used. With an object slit of  $5 \mu$  the theoretical resolving power was 40,000. The source operated at  $10^{-2}$  mm Hg consuming  $3 \times 10^{15}$  molecules of  $\text{Pb}(\text{CH}_3)_4$  per sec at 28 kv and 4 mA. Ilford  $\text{Q}_1$  plates were used for simultaneous recording of the two lines of the doublet. A value of  $222.0865 \pm 0.0007$  was found and compared. (T.R.H.)

**3877**

THE DISSOCIATION AND IONIZATION OF COMETARY MOLECULES IN THE PHOTON AND CORPUSCULAR FIELD OF SOLAR RADIATION. V. I. Cherednichenko. *Astron. Zhur.* **36**, 254-63(1959).

The influence of the photon and corpuscular solar radiation on the dissociation and ionization of cometary molecules is investigated. The investigation is based on observation data on the solar radiation obtained a.o. by rockets and sputniks. The author calculates the life time of the assumed parent cometary molecules and of the observed cometary molecules and radicals. The results are in good coincidence with observational data. (TCO)

**3878**

THERMIONIC PROPERTIES OF THORIUM DEPOSITS ON CONTROL GRID MATERIALS. J. A. Champion (General Electric Co., Ltd., Wembley, Eng.). *Brit. J. App. Phys.* **10**, 71-4(1959) Feb.

Experiments are described in which the emission is measured from thin films of thorium deposited on different platinum-molybdenum phases of approximate composition Pt,  $\text{Pt}_3\text{Mo}$ ,  $\text{Pt}_2\text{Mo}$ ,  $\text{Pt}_3\text{Mo}_2$ , and Mo. The emission from all the platinum phases is considerably lower than that from pure molybdenum. The lowest emission was observed with the  $\text{Pt}_3\text{Mo}$  phase. The emission from thorium deposited on to the  $\text{Pt}_3\text{Mo}_2$  phase decays rapidly at temperatures of 1300°C and above, whereas that from similar deposits on molybdenum does not. The emission from thin films of thorium deposited on to titanium and tungsten has also been studied. The emission from a layer on titanium that had been thoroughly pre-cleaned was found to be much less than that from a similar layer on tungsten. The application of these results to the suppression of grid emission in the presence of thoriated tungsten cathodes in transmitting tubes is discussed. (auth)

**3879**

ON THE CRYSTAL GROWTH OF ZINC SULFIDE PHOSPHOR. Yoshiro Ōtomo (Hitachi Co., Ltd., Tokyo). *Bull. Chem. Soc. Japan* **32**, 804-8(1959) Aug.

The zinc sulfide, before firing, is a large aggregate of crystallites with the crystal diameter of about 150 Å and contains about 8% of  $\alpha$ -form. The crystal growth of zinc sulfide phosphor takes place at about 500°C regardless of whether there is flux or not, but the rate of the growth is much affected by the flux. Without flux, the crystal grows as step-wise piled layers, but, with flux, it grows isotropically showing no influence from the crystal symmetry. Concerning the above difference, there has been discussion, taking into account the density of kinks at the step-wise surfaces of crystals and the change of diffusion constant of zinc sulfide molecules adsorbed at the surfaces. The transition,  $\alpha$ -form  $\leftrightarrow$   $\beta$ -form, of zinc sulfide phosphor is rather easy, but becomes difficult without flux. Also, the transition is completed in thirty minutes of firing at 800°C with the flux of 2 wt.% of sodium chloride, but it is completed within ten minutes of firing at

1000°C. It is probable that there is a metastable state of  $\alpha$ -form at about 600°C, but it requires further consideration. (auth)

### 3880

#### EXPERIMENTAL DETERMINATION OF DOSE DISTRIBUTION IN THE PROPOSED FIR GAMMA IRRADIATOR.

B. Manowitz, D. M. Richman, L. Galanter, and O. A. Kuhl (Brookhaven National Lab., Upton, N. Y.). Chem. Eng. Progr. **55**, Symposium Ser. No. 22, 127-37(1959).

An experimental program to determine the depth-dose distribution in food packages for several gamma irradiator geometries and to examine the nature of aqueous, indium-salt solutions was undertaken. The experimental results of the irradiator experiments were compared to theoretical calculations of depth-dose distributions and reactor power required for one particular irradiator geometry. (auth)

### 3881

#### ASYMPTOTIC BEHAVIOR OF HIGHER GREEN FUNCTIONS. I. F. Ginzburg and D. V. Shirkov. Nauch. Doklady Vyssheĭ Shkoly Fiz. Mat. Nauki No. 2, 143-51(1958).

The asymptotic behavior of higher Green's functions for large values of the scalar impulse arguments is treated with the aid of the group of renormalization method. The ultraviolet impulse asymptotic of higher Green's functions is determined in two steps. First the Lie equations are established and solved for the invariant charges which characterize the given variant of the field theory. Then the Lie equation is solved for the impulse asymptotic of the considered Green's function. The method is suitable for the investigation of the Green's functions of real physical scattering processes. (TCO)

### 3882

#### MAGNETOHYDRODYNAMIC GAS-IONIZING SHOCK WAVES. A. G. Kulikovskii and G. A. Lubimov (Steklov Inst. of Mathematics, Academy of Sciences, USSR). Doklady Akad. Nauk SSSR **129**, 52-5(1959) Nov. 1. (In Russian)

It is shown that in some non-stationary situations, with shock waves ionizing gas in a magnetic field, a propagating electromagnetic wave can be found in front of the shock wave. (R.V.J.)

### 3883

#### THE ROLE OF EMISSION SPECTROSCOPY IN NUCLEAR RESEARCH. G. Rossi (CISE, Milan). Energia nucleare (Milan) **6**, 696-701(1959) Nov. (In Italian)

The role of emission spectrographic techniques in nuclear research is emphasized. The usefulness and the possibilities of spectral methods as applied to analytical chemistry, isotope determinations, and high temperature measurements are reviewed. Results of typical applications are also reported. (auth)

### 3884

#### EFFECTS OF TEMPERATURE AND OUTER MAGNETIC FIELD ON THE STABILITY OF PERMANENT MAGNETS OF Al-Fe-Ni ALLOYS. E. A. Audrievskii and V. N. Mikhailoskii. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Energet. i Avtomat. No. 4, 210-14(1959) July-Aug. (In Russian)

It is shown that the stability of these magnets depends on the geometric dimensions (demagnetization factor) and the degree of preliminary demagnetization. (R.V.J.)

### 3885

#### SPECIFIC ENERGY LOSSES IN BREMSSTRAHLUNG OF HEAVY IONS BY VARIOUS SUBSTANCES. A. P. Grinberg and I. Kh. Lemberg (Inst. of Physics and Tech., Academy

of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz. **23**, 887-93(1959) July. (In Russian)

An analysis is made of the three known methods for calculating  $\epsilon$ : The Lonchamp method; the proton method; and the method of mean ion charge. These methods offer a means for obtaining more accurate data on the specific energy losses in heavy-ions bremsstrahlung.  $\epsilon$  for  $C^{12}$ ,  $O^{16}$ , and  $Ne^{20}$  is measured for nickel and aluminum. (R.V.J.)

### 3886

#### RANGE AND SPECIFIC IONIZATION OF MULTI-CHARGED IONS. Ya. A. Teplova, V. S. Nikolaev, I. S. Dmetriev, and L. N. Fateeva (Lomonosov Moscow State Univ.). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz. **23**, 894-7(1959) July. (In Russian)

Measurements were made of the range, specific ionization, and equilibrium distribution of ions with  $Z < 10$  and with ions of  $Al^{27}$ ,  $Ar^{40}$ ,  $Br^{81}$ ,  $Cl^{37}$ ,  $K^{39}$ ,  $Kr^{84}$ ,  $Mg^{25}$ ,  $Na^{23}$ , and  $P^{31}$ . (R.V.J.)

### 3887

#### STARK EFFECT AT 0.93, 1.18, AND 1.5 MILLIMETERS WAVELENGTH: DCl, DBr, AND DI. C. A. Burrus (Bell Telephone Labs., Holmdel, N. J.). J. Chem. Phys. **31**, 1270-2(1959) Nov.

Observations of the Stark effect in the microwave rotational spectra of light molecules have been extended into the sub-millimeter wave region. The Stark shifts of the  $J = 0 \rightarrow 1$  transition of deuterium chloride at 0.93 mm wavelength, and of deuterium bromide at 1.18 mm have been measured. Values of the molecular electric dipole moment  $\mu$ , obtained from analysis of the data, are found to be  $1.12 \pm 0.04$  debye for DCl and  $0.83 \pm 0.02$  debye for DBr. An error in the calculation of  $\mu$  for DI, from measurements at 1.5 mm previously reported, is corrected, and  $\mu$  for DI is found to be  $0.445 \pm 0.02$  debye. (auth)

### 3888

#### OPTICAL SPECTRA OF RARE EARTH ACTIVATED $BaTiO_3$ . Seymour P. Keller and George D. Pettit (International Business Machines Corp., Poughkeepsie, N. Y.). J. Chem. Phys. **31**, 1272-7(1959) Nov.

$BaTiO_3$  has been activated with Pr, Sm, Eu, Dy, or Er ions. The fluorescence spectra were determined at  $-196^\circ C$ ,  $-28^\circ C$ , room temperature, and at  $130^\circ C$ . Crystalline field effects on the energy levels of the rare earths and changes in these effects as the crystallographic phase of  $BaTiO_3$  is changed were studied. In particular, changes at the Curie point in going from the ferroelectric tetragonal phase to the cubic phase were searched for. The high-temperature data were largely unresolvable and no changes were observed at the low-temperature transitions in going from the tetragonal to the orthorhombic phase in the range of 5 to  $13^\circ C$  and from the orthorhombic to the rhombohedral phase in the range of  $-70$  to  $-80^\circ C$ . No crystal field splittings were observed at any temperature, leading to the possible conclusion that the rare earth centers are in positions of either high symmetry or low field strength. The fluorescence data support the hypothesis that the rare earths are present as the trivalent ions and that they can be assigned energy levels and term signatures resulting from the  $4f^n$  configuration. (auth)

### 3889

#### APPLICATION OF HIGHER ORDER BORN APPROXIMATION TO MULTIPLE ELASTIC SCATTERING OF ELECTRONS BY CRYSTALS. Kunio Fujiwara (Tokyo Univ.). J. Phys. Soc. Japan **14**, 1513-24(1959) Nov.

The calculation for the wave function of electrons in a crystal due to the first order Born approximation was extended to higher order approximations by iterated inte-



grations. As the result, Cowley and Moodie's formula for the multiple elastic scattering of electrons by crystal was derived in an improved form. The convergency of the higher order terms was illustrated by the numerical calculations on two simple examples. An elementary application was also made to the moiré patterns in electronmicrographs. (auth)

### 3890

ENERGY LOSS OF 25-keV ELECTRONS IN ATOMIC AND MOLECULAR HYDROGEN. H. Boersch, J. Geiger, and H.-J. Reich (Technische Universität, Berlin). Naturwissenschaften 46, 596-7(1959) Nov.

Photometer curves were obtained for energy loss spectra of 25-keV electrons in water at 20 and at 3,200°C. At 3,200°C a maximum appears for  $10.17 \pm 0.15$  eV which is explained by the Bethe theory. The possibility of a precision determination of  $h/e$  is suggested. (T.R.H.)

### 3891

ASYMPTOTIC BEHAVIOUR OF A PHOTON PROPAGATOR IN QUANTUM ELECTRODYNAMICS. B. A. Arbuzov. Doklady Akad. Nauk S.S.S.R. 128, 1149-52(1959) Oct. 21. (In Russian)

Previous investigations made by summarizing the simplest diagrams under the spectral integral term showed that the conditions of spectrality lead to the exclusion of the pole in the boson distribution function. Moreover, under these conditions additional terms appear with  $e^2 = 0$ . In the present work the asymptotic behavior of photon propagators is determined by means of Schwinger-Nambu equation approximations. (R.V.J.)

### 3892

ON THE GROUP OF RENORMALIZATION IN PROBLEMS WITH A FIXED SOURCE OF NUCLEONS. A. N. Tavkhelidze. Nauch. Doklady Vysshe Shkoly Fiz. Mat. Nauki No. 2, 169-73(1958).

The group of renormalization method is used for the investigation of the asymptotical behavior of Green's function in problems with a fixed source of nucleons. In spite of a missing of closed nucleon loops, the obtained asymptotic expansion shows a certain pole situation, where because of the assumptions on the behavior of the functions in the neighborhood of the poles nothing can be said. (TCO)

### 3893

$\Lambda$ -NUCLEON FORCES AND THE BINDING ENERGY OF THE  $\Lambda$ -PARTICLE IN LIGHT HYPERNUCLEI. V. A. Filimonov. Nauch. Doklady Vysshe Shkoly Fiz. Mat. Nauki No. 2, 174-80(1958).

Starting from the Lagrangian of the reciprocation of barions with  $\pi$  and K-meson fields according to Espagnat and Prentki, the forces between a  $\Lambda$ -particle and a nucleon combined with the exchange of one K-, two K-mesons, two  $\pi$ - and K- and  $\pi$ -mesons are calculated. The obtained forces are used in order to calculate the energies of the hyperkernels  $\Delta H^3$ ,  $\Delta H^4$ ,  $\Delta He^4$  and  $\Delta He^5$ . These theoretical results show a good agreement with the experimental results. (TCO)

### 3894

RADIOGRAPHIC SENSITIVITY DATA FOR THE ISOTOPES COBALT 60, IRIIDIUM 192, CESIUM 137, THULIUM 170 AND THORIUM 228. M. B. Anderson (Atomic Energy of Canada, Ltd., Ottawa). Nondestructive Testing 17, 365-70 (1959) Nov.-Dec.

Curves relating exposure to thickness of subject for 2% radiographic sensitivity have been experimentally determined for the five isotopes  $Co^{60}$ ,  $Ir^{192}$ ,  $Cs^{137}$ ,  $Tm^{170}$ , and  $Th^{228}$ . A medium speed fine grained film and a fast film

were used in the radiographing of slotted iron wedges up to 9 inches thick and 2% sensitivity was obtained from 0.05 to 9 inches of iron. Aluminum wedges were also radiographed with  $Tm^{170}$  and 2% sensitivity obtained from 0.04 to 3.5 inches. (auth)

### 3895

ISOTOPIC SHIFT IN THE SPECTRUM OF ZrI. Yu. (In.) P. Dontsov. Optics and Spectroscopy (English Translation) 6, No. 1, 1-3(1959) Jan.

Using a tube with a hollow cathode cooled by liquid nitrogen and a Fabry-Perot interferometer joined with an ISP-51 three-prism spectrograph, an investigation was made of the isotopic structure of the spectrum of zirconium. The results are tabulated as values of the isotopic shift between pairs of isotopes. The classification of certain lines of the neutral zirconium atom was clarified. An estimate was made of the volume effect between the isotopes  $Zr^{90}$  and  $Zr^{92}$ . (auth)

### 3896

ISOTOPIC ANALYSIS OF THE ABSORPTION SPECTRUM OF COPPER IODIDE. G. V. Veinberg. Optics and Spectroscopy (English Translation) 6, No. 1, 4-7(1959) Jan.

Using a DSF-3 spectrograph, the isotopic shifts of the absorption spectrum of copper iodide were investigated and compared to the values determined by Mulliken. A comparison of the isotopic shift for the absorption spectrum at  $\lambda = 4090.8$  and  $4054.0$  Å was made between  $Cu^{63}I$ ,  $Cu^{65}I$ , and  $CuI$ . The rotational structure of some of the lines was studied. (C.J.G.)

### 3897

PROLONGED LUMINESCENCE OF DIBENZYL AND DIPHENYLAMINE CRYSTALS UNDER PHOTO- AND  $\beta$ -EXCITATION. T. P. Belikova. Optics and Spectroscopy (English Translation) 6, No. 1, 72(1959) Jan.

The decay curves of prolonged luminescence of dibenzyl and diphenylamine crystals under photo- and  $\beta$ -excitation were determined. For dibenzyl, it was found that  $\tau = 0.85 \pm 0.02$  sec and for diphenylamine,  $\tau = 0.35 \pm 0.02$  sec. (C.J.G.)

### 3898

OBSERVATION OF THE SUPPRESSION EFFECT ON BREMSSTRAHLUNG. P. H. Fowler, D. H. Perkins, and K. Pinkau (Univ. of Bristol, Eng.). Phil. Mag. (8) 4, 1030-4(1959) Sept.

The distance  $y$  between the primary pair of a photon-initiated cascade and its first daughter pair was measured on 58 electromagnetic showers of energy below 1000 BeV, and on 47 above 1000 BeV. An average value of  $y$  of 10 mm was found for the low energy group, in agreement with the predictions of the Bethe-Heitler and Migdal theories. For the high energy cascades the average value for  $y$  was 13.5 mm, in agreement with the prediction by Migdal's calculations, and in disagreement with the value predicted by the Bethe-Heitler theory. (auth)

### 3899

GROUND STATE OF A BOSE SYSTEM OF HARD SPHERES. Tai Tsun Wu (Inst. of Advanced Study, Princeton and Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. 115, 1390-1404(1959) Sept. 15.

It is shown that the pseudopotential method can be extended to yield further terms in the low-density expansion of the ground-state energy of a system of Boltzmann or Bose particles with hard-sphere interaction. Two terms beyond the known result are found, and the expansion is no longer a power series in  $(a^3\rho)^{1/2}$ . Other related properties of the system are discussed. (auth)

**3900****ENERGY LEVELS FOR RARE EARTH IONS SUBJECT BOTH TO EXCHANGE AND CRYSTALLINE FIELDS.**

Robert L. White and John P. Andelin, Jr. (Hughes Aircraft Co., Culver City, Calif.). Phys. Rev. **115**, 1435-9(1959) Sept. 15.

The term splitting was calculated for the lowest lying J state of the rare earth ions samarium through ytterbium for the case in which the ions are simultaneously subjected to exchange and crystalline fields of arbitrary relative magnitude. The crystalline field is taken to be cubic and as representing the potential of eight negative ions situated at the corners of a cube. The calculation is carried out for the magnetic axis in the two major (local) crystalline directions, [100] and [111]. The relevance of these calculations to the rare earth iron garnets is discussed. (auth)

**3901****MAGNETIZATION OF COMPOUNDS OF RARE EARTHS WITH PLATINUM METALS.** R. M. Bozorth, B. T. Matthias, H. Suhl, E. Corenzwit, and D. D. Davis (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. **115**, 1595-6(1959) Sept. 15.

Measurements were made of the Curie points and magnetic moments of three series of compounds (Laves phases)  $\text{M}\text{Ir}_2$ ,  $\text{M}\text{Os}_2$ , and  $\text{M}\text{Ru}_2$ , where M is a rare-earth element. The Curie point is highest (85°K) for the compounds containing Gd and falls away when the rare earths have larger or smaller atomic numbers. This dependence of Curie point on the rare-earth element is in accord with the idea that the principal exchange interaction is between the spins of the 4f shell of the rare-earth ions and the conduction electrons. The magnetic moments are closely related to, but differ somewhat from, the values of Jg for the trivalent ions of M. (auth)

**3902****AUTO MODEL MOTION OF GAS WITH SHOCK WAVE PROPAGATION BY EXPONENTIAL LAW ALONG THE INERT GAS.** G. L. Grozdovskii and N. L. Krasheninnikova. Priklad. Mat. i Mekhan. **23**, 936-9(1959) Sept.-Oct. (In Russian)

A mathematical analysis is made of a general class of automodel propagation which includes the out going and converging flows (as in the event of peripheral explosions). (R.V.J.)

**3903****A SELF-CONSISTENT CALCULATION OF THE GRAPHITE  $\pi$  BAND.** T. E. Peacock and R. McWeeny (University Coll., North Staffordshire, Eng.). Proc. Phys. Soc. (London) **74**, 385-94(1959) Oct. 1.

The approximate self-consistent field theory is applied to a two-dimensional crystal, the graphite layer. The crystal orbitals for the  $\pi$ -electrons are constructed from atomic orbitals in the usual tight binding approximation, but the methods of many-electron theory are used in setting up the self-consistent field. Matrix elements of the one-electron Hartree-Fock Hamiltonian are expressed in terms of the  $\pi$ -electron density matrix, whose elements may be evaluated by integration over the occupied region of k space, and are systematically adjusted until Hamiltonian and charge density are self-consistent. The results suggest that with the further development of automatic computation similar calculations on three-dimensional crystals will become feasible. (auth)

**3904****ELECTRON LOSS FROM FAST NEGATIVE IONS OF ATOMIC HYDROGEN PASSING THROUGH ATOMIC HYDROGEN.** M. R. C. McDowell and G. Peach (Royal

Holloway Coll., Englefield Green, Surrey, Eng.). Proc. Phys. Soc. (London) **74**, 463-72(1959) Oct. 1.

Born's approximation is used to calculate the cross sections of the processes  $\text{H}(1s) + \text{H}^-(1s^2) \rightarrow \text{H}(1s \text{ or } 2p) + \text{H}(1s \text{ or } 2p) + e$  at impact energies between 2.5 kev and 10 Mev. The sensitivity of the cross section of the process to the choice of bound and free  $\text{H}^-$  wave function is examined. The electron loss cross section  $\sigma_{-1,0}$  is approximated by a sum rule, for the simplest choice of wave function. The results are compared with those of Allison for  $\text{H}^-$  electron loss in  $\text{H}_2$ . The energy distribution of ejected electrons at high impact energies is also given. (auth)

**3905****ELECTRON COLLISION CROSS SECTIONS IN HELIUM.** D. T. Stewart and E. Gabathuler (Queen's Univ., Belfast). Proc. Phys. Soc. (London) **74**, 473-7(1959) Oct. 1.

Electron collision cross sections in helium were measured by an optical method, using a photoelectric spectrophotometer. The results are in general agreement with those of previous workers. Some values for the cross sections for collisions of the second kind in helium are also given. (auth)

**3906****THE PROBLEM OF OPERATION OF "ATOMIC" CURRENT SOURCES WITH DOUBLE ENERGY CONVERSION.** V. S. Vavilov, B. M. Vul, G. V. Galkin, and S. A. Fridman (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State **1**, 748-9(1959) Nov.

The possibility of double conversion (energy of beta particles  $\rightarrow$  light  $\rightarrow$  electric energy) in silicon photocells, luminophors with various spectra, and a radiation source in the form  $\text{Sr}^{90} - \text{Y}^{90}$  was studied. A total flux of beta-particles equal to  $1.3 \times 10^9 \text{ sec}^{-1}$  incident on the silicon photocell produced a current of  $1.54 \mu\text{a}$  and the emf was equal to 138 mv, giving a conversion efficiency relative to the energy of radiation incident on the phosphor of 0.1%. The application of  $\text{Pm}^{147}$  to the luminophor will increase the over-all efficiency of the converter to 1%. (C.J.G.)

**3907****EMISSION OF SECONDARY ELECTRONS UNDER THE ACTION OF LITHIUM, BORON, AND NITROGEN IONS WITH AN ENERGY UP TO 10 Mev.** A. I. Akishin and S. S. Vasil'ev (Moscow State Univ.). Soviet Phys.-Solid State **1**, 755-6(1959) Nov.

The dependence of the  $\gamma$  coefficients on ion energy — lithium, boron, and nitrogen — in bombarding a target consisting of copper-beryllium alloy at 10 Mev is graphically presented. (C.J.G.)

**3908****ON THE SOLUTION OF INSTATIONARY PROBLEMS OF RADIATION TRANSFER THEORY.** I. N. Minin. Vestnik Leningrad. Univ., Ser. Mat. Mekh. i Astron. No. 13(3), 137-41(1959).

Instationary problems of the radiation transfer theory are investigated. The investigation is carried out with means of Laplace transformations and with statistical methods. The radiation intensity on the boundary is obtained as well as in the medium itself. The known solutions of the corresponding stationary problems are used. The probability of the quantum reflection at a semi-infinite medium in the time interval  $u$  to  $u + du$  is determined. (TCO)

**3909****PHYSICS OF THE ATOM.** M. Russell Wehr and James A. Richards, Jr. Reading, Mass., Addison-Wesley Publishing Company, Inc., 1960. 430p. \$8.50.



The book is designed to meet the need for a better understanding of the atomic age. It is an introduction suitable for any student with a background in college physics and mathematical competence at the level of calculus. Topics considered include the atomic view of matter, electricity, solids, and radiation; the atomic models of Rutherford and Bohr; relativity; x rays; waves and corpuscles; natural radioactivity, nuclear reactions and artificial radioactivity; nuclear energy; and cosmic rays and the fundamental particles. (W.D.M.)

**3910**

GRUNDLAGEN UND ANWENDUNG DER RÖNTGENFEINSTRUKTUR-ANALYSE. (Fundamentals and Application of X-ray Fine Structure Analysis). Hans Neff. Munich, R. Oldenbourg, 1959. 447p.

A book on the fundamentals and application of x-ray fine structure analysis is presented. In the first part, after a brief introduction on the fundamentals and techniques, the extensive data for the comprehension of all diffraction phenomena is made available. In the second part the investigation methods and the evaluation of photographs and diagrams for crystal powders only are discussed. The basic laws of crystal chemistry are presented in the third part. (J.S.R.)

**3911**

THE PRODUCTION AND SLOWING DOWN OF NEUTRONS. Edoardo Amaldi. p.1-659 of "Handbuch der Physik. Band XXXVIII/2. Neutronen und Verwandte Gammastrahlprobleme. (Encyclopedia of Physics. Volume XXXVIII/2. Neutrons and Related Gamma Ray Problems)." S. Flügge, ed. Berlin, Springer-Verlag, 1959. 873p.

The presented material, of a marked experimental character, can be considered as a general introduction to the more specialized ones dealing with particularly important branches of neutron physics. Discovery of the neutron, neutron properties, neutron interactions, artificial radioactivity, slowing down mechanism, properties of slow neutrons and the quantum mechanical representation of processes produced by neutrons, slow neutron velocities, selective capture of slow neutrons, and the main processes involved in the slowing down of neutrons are treated in detail. (W.D.M.)

**3912**

PENETRATION AND DIFFUSION OF X RAYS. U. Fano, L. V. Spencer, and M. J. Berger. p.660-868 of "Handbuch der Physik. Band XXXVIII/2. Neutronen und Verwandte Gammastrahlprobleme. (Encyclopedia of Physics. Volume XXXVIII/2. Neutrons and Related Gamma Ray Problems)." S. Flügge, ed. Berlin, Springer-Verlag, 1959. 873p.

X-ray penetration under conditions where photons are likely to experience repeated Compton scattering before their eventual absorption is treated. The results of the study have applications in radiology and nuclear engineering, particularly in reactor shielding design. Attention is directed to photon energies above ~20 kev. The background of information on elementary processes is surveyed and the theory of multiple processes is constructed from the data. The procedures and results of numerous calculations of x-ray distributions are reported. Monte Carlo calculations of the effects of inhomogeneities and boundaries are discussed. Experiments that do not relate directly to existing calculations are reported. (W.D.M.)

## Astrophysics and Cosmology

**3913**

ABUNDANCES OF THE RARE-EARTH NUCLEI PRODUCED

BY RAPID NEUTRON CAPTURE IN SUPERNOVAE.

Robert A. Becker and William A. Fowler (California Inst. of Tech., Pasadena). *Phys. Rev.* **115**, 1410-14(1959) Sept. 15.

Calculations were carried out, following the method of Burbidge, Burbidge, Fowler, and Hoyle, for the abundances of nuclei in the rare-earth region which are produced in the rapid neutron-capture process thought to occur in supernovae. The recently available rare-earth mass differences of Johnson and Bhanot were employed. The calculated abundances agree, in general, with those given by Suess and Urey. The results of the computations support the work of Burbidge, Burbidge, Fowler, and Hoyle which showed the effect of spheroidal deformation above the closed shell at  $N = 126$  in enhancing the production of  $\text{Th}^{232}$ ,  $\text{U}^{235}$ ,  $\text{U}^{238}$ ,  $\text{Ce}^{140}$ , etc., in supernovae. The effect of different combinations of temperature and neutron density in enhancing certain relative abundances is discussed briefly. (auth)

## Cosmic Radiation

**3914**

THE SUN AS A SOURCE OF COSMIC RAYS OF INTERMEDIATE ENERGIES. J. Katzman (National Research Council, Ottawa). *Can. J. Phys.* **37**, 1207-15(1959) Nov.

The cosmic ray intensity as measured with an extremely narrow-angle telescope,  $1.2 \times 10^{-3}$  steradians, and with 96 inches of lead as absorber for the period January 1, 1955, to December 31, 1958, shows an increase of 20%. This increase is attributed to particles coming from the sun. It is shown that the change in hour of maximum of the first and second harmonics can be explained by a change in the relative importance of the impact zones. This phenomenon is attributed to a change in the number and polarity of sunspots. (auth)

**3915**

LOW ENERGY SPECTRUM OF THE SEA LEVEL ELECTRONS AND MUONS AT 12°N. Nilima Mishra (Basu) and M. S. Sinha (Bose Inst., Calcutta). *Indian J. Phys.* **33**, 335-45(1959) Aug.

The slow electron and muon components of cosmic rays at sea level and 12°N geomagnetic latitude were studied with a multplate cloud chamber triggered by a coincidence-anti-coincidence system. The differential energy spectra of these electrons were obtained for energies at 5 to 300 Mev. The electron spectrum is found to be represented by a simple power law of the form  $E^{-1.2}$ . In the range interval 7 to 60 g/cm<sup>2</sup> of air equivalent the differential range spectrum of muons was determined. The spectrum was found to be flat with a mean intensity  $(5.89 \pm 0.15) \times 10^{-6}$ /g sec sterad in the range interval 15 to 60 g/cm<sup>2</sup> of air equivalent. Below this range the muon intensity falls off gradually. A comparison of the total intensities of muons and electrons was given. (auth)

**3916**

ON THE RATE OF FINE COSMIC MATTER PENETRATION FROM IONOSPHERE TO LOWER ATMOSPHERE. A. A. Dmitriev (Inst. of Applied Geophysics, Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Geofiz.* No. 10, 1468-72(1959) Oct. (In Russian)

The penetration of fine cosmic particles into the lower atmosphere by turbulent mixing is studied using the scheme in which the turbulent kinematic viscosity factor rises linearly with height. (R.V.J.)

**3917**

NORTH-SOUTH ANISOTROPY AND ANTICIPATORY

# INCREASE OF INTENSITY ASSOCIATED WITH THE COSMIC-RAY STORM OF FEBRUARY 11, 1958.

V. Sarabhai (Physical Research Lab., Ahmedabad, India) and R. Palmeira (Massachusetts Inst. of Tech., Cambridge). *Nature* **184**, 1204-7(1959) Oct. 17.

Solar and terrestrial observations associated with the cosmic-ray storm of February 11, 1958, are discussed relative to North-South anisotropy and the anticipatory increase of intensity. A chronology of events associated with the Forbush Decrease of February 11 is given and the connection between these events is discussed. (C.J.G.)

## 3918

HEAVY PRIMARY COSMIC RAYS AT GEOMAGNETIC LATITUDE OF 41°N. O. B. Young and H. Y. Chen (Southern Illinois Univ., Carbondale, Ill.). *Phys. Rev.* **115**, 1719-21(1959) Sept. 15.

The results from 9 balloon flights at geomagnetic latitude 41°N of altitude range from 70,000 to 100,000 feet are reported. Only primaries of  $Z \geq 10$  are considered. 2410 tracks are involved, in Ilford G-5 and G-0 emulsion exposures. The charge spectra, flux, mean free paths, and angular distributions are given. (auth)

## 3919

PRIMARY COSMIC-RAY PROTON AND ALPHA-PARTICLE INTENSITIES AND THEIR VARIATION WITH TIME. Peter Meyer (Enrico Fermi Inst. for Nuclear Studies, Chicago). *Phys. Rev.* **115**, 1734-41(1959) Sept. 15.

A series of high-altitude balloon flights was carried out in 1957 and 1958 to study the flux of primary cosmic-ray protons and  $\alpha$  particles during variations in the total cosmic-ray intensity. Results were obtained for  $\alpha$  particles with energies exceeding 530 Mev/nucleon under 13.5 g/cm<sup>2</sup> of air. During a large Forbush-type decrease the  $\alpha$ -particle and proton intensities were closely correlated. This demonstrates that a modulation mechanism is operating on both components. At certain times variations in the  $\alpha$ -particle intensity were observed within a few hours which were not accompanied by corresponding changes in the proton flux. This is tentatively ascribed to an anisotropy in the  $\alpha$ -particle flux that reaches the earth. While there existed an intensity decrease in the proton flux between 1957 and 1958 which is also observed in the neutron monitor station data, no such variation occurred in the  $\alpha$ -particle flux. A division of the  $\alpha$  particles into two energy groups (450 Mev/nucleon  $\leq E_1 \leq 960$  Mev/nucleon and  $E_2 \geq 960$  Mev/nucleon) shows: that the Forbush decrease is of the same magnitude in both energy groups; that the hourly flux increase observed in some flights is about the same in both energy groups; and that from 1957 to 1958 the flux in the low-energy group increased, while it decreased in the high-energy interval, contrary to the well-known behavior of the proton flux. These independent  $\alpha$ -particle flux variations cannot be explained by any of the modulation mechanisms so far proposed. It is suggested that occasional solar production of  $\alpha$  particles may be responsible for the results. The absolute flux of  $\alpha$  particles with energies exceeding 560 Mev/nucleon at the top of the atmosphere was measured on five different days. (auth)

## 3920

MOMENTUM SPECTRUM OF THE VAN ALLEN RADIATION. Hannes Alfvén (Royal Inst. of Tech., Stockholm). *Phys. Rev. Letters* **3**, 459-60(1959) Nov. 15.

The momentum spectrum of cosmic radiation obeys a power law,  $N = \text{const } p^{-n}$ , with  $n$  approximately constant (2.6) from  $10^{10}$  to  $10^{18}$  ev/c. An attempt is made to explain

the Van Allen radiation spectrum by the same mechanism. (C.J.G.)

# Criticality Studies

## 3921 WCAP-1404

Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.

MULTI-REGION REACTOR LATTICE STUDIES. Quarterly Progress Report for the Period June 1 to September 30, 1959. Ira H. Coen. Oct. 30, 1959. 20p. Contract AT(30-1)-2176. OTS.

The Multi-region Reactor Lattice Studies Program is a highly directed research and development program for both experimental and analytical work on multi-region reactor cores, and is centered around a series of critical experiments to be performed at WREC facility. The experiments will utilize stainless steel clad UO<sub>2</sub> fuel rods of three different enrichments and will be carried out at two moderating ratios. Critical experiments at high water-to-metal ratios were performed using the 2.7% enriched UO<sub>2</sub> stainless steel clad fuel rods and the associated core components from the Yankee critical experiment. (W.D.M.)

## 3922

THE SUBCRITICAL ASSEMBLY IN ENGINEERING TEACHING. W. F. Fagen and Joseph Well (Univ. of Florida, Gainesville). *Chem. Eng. Progr.* **55**, Symposium Ser. No. 22, 65-75(1959).

A description is given of the University of Florida subcritical assembly. Reactor operation and control are discussed with respect to engineering training. Experiments for the determination of radiation hazards are given. (C.J.G.)

# Elementary Particles

## 3923 MURA-530

Midwestern Universities Research Assn., Madison. ENERGY AND ANGULAR DISTRIBUTION OF THE PARTICLES RESULTING FROM THE COLLISION OF A 15 BeV PROTON WITH A NUCLEON AT REST. Willy Smith. Sept. 8, 1959. 36p. Contract AT(11-1)-384. OTS.

On the basis of the scarce information available from cosmic ray experiments, the energies and angular distribution of the particles resulting from the collision of a high-energy proton with a nucleon at rest are determined. Estimated values are presented and it is remarked that the multiplicities as stated apply only to nucleon collisions with light nuclei. Of some interest is the fact that with the only exception of the low energy gammas, all the particles are emitted in the forward direction in the laboratory frame. For the highly energetic particles, this ejection takes place within a very narrow cone. (auth)

## 3924 UCRL-8692

California. Univ., Berkeley. Lawrence Radiation Lab. THE LIFETIME AND DECAY MODES OF NEGATIVE K MESONS (thesis). Norris A. Nickols. Sept. 1959. 50p. Contract W-7405-eng-48. OTS.

A large emulsion stack exposed to an enriched K<sup>-</sup>-meson beam analyzed by 180-deg magnetic bending has been used to measure the mean lifetime and decay branching ratios of K<sup>-</sup> mesons. In a systematic study of 2582 K<sup>-</sup> mesons, 86 events in flight with no stable prong, blob, or Auger electron were observed. Of these, 48 had one lightly ionizing secondary and 38 had no visible secondary. No  $\tau^-$  were observed. Space angles were measured and momenta of



secondaries were determined from their ranges or from blob-density measurements. The residual range accurately determined the  $K^-$ -meson momentum at the decay point, because the 180-deg bending provided high momentum resolution. A probability analysis was used to calculate the relative populations of the various decay modes and of nuclear interactions that simulate decays. Independent estimates of upper and lower limits to the number of decays present were made. The percent branching ratios for the various decay modes measured are as follows:  $K_{\mu 2}^-(56.5 \pm 7.3)$ ,  $K_{\mu 3}^-(9.5 \pm 4.3)$ ,  $K_{\pi 2}^-(26.3 \pm 6.6)$ ,  $K_{\pi 3}^-(2.8 \pm 2.4)$ ,  $K_{e 3}^-(4.9 \pm 3.2)$ ,  $\tau^-(0.0 \pm 2.1)$ . The  $K^-$ -meson mean lifetime is  $1.25_{-0.17}^{+0.22} \times 10^{-8}$  sec. (auth)

### 3925

FIELDS OF AN ACCELERATED POINT CHARGE. B. C. Carlson (Iowa State Univ. of Science and Tech., Ames). Am. J. Phys. **27**, 669-70(1959) Dec.

The magnetic field of a moving point charge is the vector product of its electric field with a unit vector directed from the retarded position of the charge to the field point. This relation is usually derived only after both fields are calculated as functions of the retarded position, velocity, and acceleration. Using Liénard-Wiechert potentials a derivation is given which does not require a detailed calculation of either field. (C.J.G.)

### 3926

A NEW METHOD FOR MEASURING THE ATTACHMENT OF SLOW ELECTRONS IN GASES. L. G. H. Huxley, R. W. Crompton, and C. H. Bagot (Univ. of Adelaide). Australian J. Phys. **12**, 303-8(1959) Sept.

A technique is given for simultaneously determining the attachment coefficient  $\alpha_a$  and Townsend's energy factor  $k_1$  by measuring currents received by a central disk placed between the cathode and anode in the diffusion chamber. Measurements of  $\alpha_a$  and  $k_1$  in oxygen were determined to be 0.162 and 117, respectively. (C.J.G.)

### 3927

INVESTIGATION ON A METHOD FOR THE CALCULATION OF THE ABNORMAL MAGNETIC MOMENT OF THE NUCLEON. Yvonne Héno. Compt. rend. **249**, 1469-70(1959) Oct. 19. (In French)

The variation of the ratio of the abnormal parts of the magnetic moments of the neutron and proton is given for the case where a relativistic "form factor" is used. It is shown that in non-local theory a redefinition of the gage invariance is made necessary. (tr-auth)

### 3928

APPLICATION OF THE WILLIAMS AND WEIZSÄCKER METHOD TO THE INELASTIC SCATTERING OF THE  $\mu$  MESON. Paul Kessler. Compt. rend. **249**, 1471-3 (1959) Oct. 19. (In French)

The Williams and Weizsäcker approximation method is used to evaluate the importance of various inelastic scattering processes of the  $\mu$  meson in a study of the elastic scattering. The inelastic scattering processes considered are nuclear reactions,  $\pi$  meson production, electron pair formation, stripping atomic electrons, and bremsstrahlung. It is concluded that the various inelastic scattering processes will not interfere with the experimental determination of elastic scattering. (J.S.R.)

### 3929

ON TESTING THE CONSERVATION OF PARITY IN STRONG INTERACTION AT HIGH ENERGIES. V. G. Solov'ev (Joint Inst. of Nuclear Research, Dubna, USSR). Doklady Akad. Nauk SSSR **129**, 68-71(1959) Nov. 1. (In Russian)

An analysis is made of processes with  $N$  particles ( $N \geq 3$ ) in their finite state. The asymmetries of particle distributions which assert non-conservation of parity in strong interactions are discussed and the reactions and particles where such asymmetries are most probable are investigated. Special attention is given to hyperon decay events. (R.V.J.)

### 3930

ON THE  $\beta$  DECAY OF A NEUTRON WITH ORIENTED SPIN. B. K. Kerimov (Lomonosov Moscow State Univ.). Izvest. Akad. Nauk, S.S.S.R., Ser. Fiz. **23**, 924-8(1959) July. (In Russian)

The theory of Dirac particles with oriented spin was used for calculating the angular asymmetry and the order of longitudinal polarization of electrons produced in the  $\beta$  decay of a polarized free neutron ( $n \rightarrow p + e^- + \gamma$ ). (R.V.J.)

### 3931

ELECTRON-POSITRON PAIR PRODUCTION BY COLLISION OF TWO POLARIZED  $\gamma$  QUANTA. F. S. Sadykh and B. K. Kerimov (Lomonosov Moscow State Univ.). Izvest. Akad. Nauk, S.S.S.R., Ser. Fiz. **23**, 929-32(1959) July. (In Russian)

The electron-positron pair produced in polarized and non-polarized  $\gamma$  quantum collisions is discussed. The theory of Dirac particles with oriented spin is used for calculating the effective cross section for pair production in collisions of two longitudinally polarized  $\gamma$  quanta, considering the longitudinal polarization of the produced pair. (R.V.J.)

### 3932

A NEW CALCULATION PRINCIPLE OF ATOMIC AND RADIATION PHYSICS. III. K. Nowak. Neue Physik No. 1, 1-29(1959). (In German)

The character of the radiation phenomena observable as the radiation quantum, neutrino, and antineutrino is considered. The energy content of the rest mass and the magnitude of the photon charge-mass are also discussed. A mathematical formulation is given for a mass and charge transfer, the radiation energy, and the radiation pulse. A uniform mathematical interrelationship is proposed for all radiation processes. (J.S.R.)

### 3933

THE CHARACTER OF LIGHT-LIKE RADIATIONS AND THE STRUCTURE OF "ELEMENTARY PARTICLES." K. Nowak. Neue Physik No. 2, 33-55(1959). (In German)

It is shown that the field theories resulting from mechanical conceptions do not represent accurately the physical facts and the latest experimental data. As a substitution of the abstract field conceptions with respect to radiation phenomena, the theory of an electromagnetic spiral wave motion was developed from the electrical radiation particle called the photon. The determined value of the photon charge mass agrees with an assumed building of electrons from photons of different polarity and establishes the stability and mass and charge behavior of the electron. (tr-auth)

### 3934

ARGUMENT FOR THE CONCEPTION OF THE ELECTROMAGNETIC CORPUSCULAR SPIRAL WAVE. K. Nowak. Neue Physik No. 2, 56-62(1959). (In German)

It is shown that the processes of nuclear fusion support the conception that the character of electromagnetic oscillations of corpuscular or undulatory radiation are to be seen in a spiral motion of charge carriers. (J.S.R.)

### 3935

THE ANALYSIS OF 4.5 BeV NEGATIVE PION INTERAC-

TIONS IN NUCLEAR EMULSION. H. H. Aly, J. G. M. Duthie, and C. M. Fisher (Univ. of Bristol, Eng.). Phil. Mag. (8) 4, 993-1005(1959) Sept.

Two hundred nuclear interactions produced in Ilford G5 nuclear emulsion by 4.5 Bev  $\pi^-$  mesons were analyzed. The transverse momentum of those secondary shower particles identified as pions has an average value over all angles of  $290 \pm 50$  Mev/c. The mean multiplicity of shower particles from the interactions is  $2.0 \pm 0.1$  and is independent of the number of heavily ionizing prongs  $N_h$ . About 90% of the shower particles were estimated to be pions. The angular distribution in the C-system is anisotropic with a mean value for  $|\cos \theta^*|$  of  $0.58 \pm 0.03$ . Assuming that secondary pions are emitted symmetrically backwards and forwards from a single collision system, the observed angular distribution of shower particles was used to determine the effective mass of the collision partner. It is found to be 1.40 proton mass units. If the total distribution is divided into groups with respect to  $N_h$  it is found that events having  $N_h \leq 7$  yield a value of 0.77 proton mass units while those having  $N_h > 7$  yield 2.3 proton mass units. (auth)

### 3936

THE MULTIPLE SCATTERING OF PARTICLES OF OPPOSITE CHARGE. I. S. Hughes and D. Sinclair (Univ. of Glasgow). Phil. Mag. (8) 4, 1013-16(1959) Sept.

Earlier investigations by a number of workers revealed an apparent difference in the multiple scattering of positively and negatively charged particles which is much greater than that predicted by theory. Experiments were carried out in which the existence of such a difference was investigated for the multiple scattering of positive and negative  $\mu$  mesons,  $\pi$  mesons, and electrons in nuclear emulsions. No significant difference was found. (auth)

### 3937

LINKED-DIAGRAM EXPANSIONS FOR QUANTUM STATISTICAL MECHANICS. A. E. Glassgold, Warren Heckrotte, and Kenneth M. Watson (Univ. of California, Berkeley). Phys. Rev. 115, 1374-89(1959) Sept. 15.

A general method of calculation is described for quantum statistical mechanics. It is based on a simplification of the Laplace transform of the density matrix which follows from a theorem due to Hugenholtz. The basic result is that an element of the density matrix can be written as a sum over graphs, with the contribution of each graph factored into contributions from connected or linked graphs. Applied to the grand partition function, the exponential formula of Bloch and DeDominicis is obtained in a simple way. A similar formula is then derived for the canonical ensemble for the case of a nondegenerate gas. In this way the familiar result of Uhlenbeck and Beth is obtained for the second virial coefficient. Techniques are also introduced for evaluating ensemble averages of operators. In this connection, some care must be exercised in the case of diagonal operators. These methods are used to calculate the pair-correlation function for a system of fermions interacting through short-range forces. (auth)

### 3938

POSITRON ANNIHILATION IN HELIUM. Thomas Bruce Daniel and Robert Stump (Univ. of Kansas, Lawrence). Phys. Rev. 115, 1599-1600(1959) Sept. 15.

Positron mean lives were measured in helium gas over a wide temperature range at densities from 4.6 to 534 times the STP density and in liquid helium at 4.2 and 5.1°K. The orthopositronium mean life in the liquid at 5.1°K was found to be  $(9.4 \pm 0.6) \times 10^{-8}$  sec which differs little from

the lifetime in liquid at 4.2°K. Except at very low temperatures, the pick-off rate in gas agreed moderately well with theory. The low pick-off rate associated with orthopositronium in liquid was observed also in the gas at temperatures below 9°K for densities greater than 250 times the STP density. (auth)

### 3939

QUANTUM-MECHANICAL THREE-BODY PROBLEM. Leonard Eyges (Massachusetts Inst. of Tech., Lexington). Phys. Rev. 115, 1643-55(1959) Sept. 15.

The quantum-mechanical problem of three spinless particles is treated with the boundary condition that the logarithmic derivative of the wave function be a prescribed constant at each of the three boundaries  $|r_1 - r_2| = a$ ,  $|r_2 - r_3| = a$ ,  $|r_1 - r_3| = a$ . This boundary condition is roughly equivalent to an interparticle potential which consists of a hard core plus a strong short-range attractive part. The eigenfunctions and eigenvalues of the system are given by the solutions of an infinite set of coupled homogeneous integral equations. The equations involve partial wave expansions in the interparticle distances and can often be truncated with good approximation by taking only a finite number of partial waves. The solution of these equations for the ground state of the system is discussed taking relative S-waves only, for which case the infinite set of equations reduces to a single integral equation in one variable. (auth)

### 3940

BINDING EFFECT CORRECTIONS IN THE ENERGY-LOSS DISTRIBUTION FUNCTIONS FOR CHARGED PARTICLES PASSING THROUGH THIN ABSORBERS. Walter Rosenzweig (Columbia Univ., New York). Phys. Rev. 115, 1683-6(1959) Sept. 15.

In the theoretical treatment of the statistical fluctuation in energy-loss of charged particles passing through thin absorbers, terms which are of the order of the electron binding energy are ordinarily neglected. The corrections required, when this is no longer justified, are discussed in particular reference to the development by Symon, which has as its limiting cases the Gaussian distribution derived by Bohr, and Landau's distribution. Formulas are presented which give the correction for each of the three weighted parameters appearing in Symon's derivation. The corrected parameters can then be used in conjunction with Symon's curves to obtain the energy-loss distribution appropriate for a given set of conditions. An illustration is presented for the cases of 5-Mev protons and 5-Mev alpha particles. (auth)

### 3941

INTERFERENCE EFFECTS OF THE RETARDATION TERM IN PION PHOTOPRODUCTION. A. M. Wetherell (California Inst. of Tech., Pasadena). Phys. Rev. 115, 1722-6(1959) Sept. 15.

It is shown that the difference in behavior of the high-energy (>450 Mev c.m.) total photoproduction cross sections for  $\pi^+$  and  $\pi^0$  can be explained by the presence of the retardation term in the case of the  $\pi^+$  production. The analogy with the behavior at the  $(\frac{3}{2}, \frac{3}{2})$  resonance is noted. The discussion provides an explanation for the difference in center-of-mass energies of the lower high-energy peak found in  $\pi^-$ -p scattering and the corresponding peak in the  $\pi^+$  photoproduction. It is felt that the discussion contributes some evidence for the resonance nature of the peaks. (auth)

### 3942

$K^+$ -DEUTERON SCATTERING IN THE IMPULSE APPROXIMATION. Erasmo M. Ferreira (Imperial Coll. of



Science and Tech., London). *Phys. Rev.* **115**, 1727-9 (1959) Sept. 15.

It is suggested that a phenomenological analysis using the impulse approximation of the processes occurring in the scattering of  $K^+$  mesons by deuterons may be used to get the phase-shifts for the  $T = 0$  isotopic spin state. Typical curves are given for the elastic, elastic plus inelastic and charge exchange scattering differential cross sections of 100-Mev  $K^+$  mesons by deuterons on the assumption that only S-waves contribute and for various ratios of the  $T = 1$  and  $T = 0$  isotopic spin states phase shifts. (auth)

### 3943

STRANGE PARTICLE PRODUCTION BY BEVATRON NEUTRONS IN PROPANE. Charles O. Dechand (Yale Univ., New Haven). *Phys. Rev.* **115**, 1730-4 (1959) Sept. 15.

A liquid propane bubble chamber was exposed to a beam of neutrons with energies up to 6 Bev from the Bevatron. 10,000 pictures of interactions in the hydrocarbon were scanned to detect neutral heavy unstable particles. 349 neutral V-events were found, most of which came from the stainless steel walls of the chamber; 86% of these events could be identified as one or the other or either of the neutral strange particles,  $\Lambda^0$  or  $\Theta^0$ . The  $\Lambda^0/\Theta^0$  ratio is about 0.6. 8200 stars of 2 or more prongs formed by neutrons interacting in the liquid propane were observed in the chamber and 17 of these produced  $V^0$ s. An additional 5  $V^0$ s were formed in single-prong events produced by neutrons, and 8 others were produced in events in the propane caused by charged particles. The energy spectrum of the incident neutrons was estimated from study of  $\pi$ -meson production interactions in the hydrogen. The distribution shows that the neutrons had energies up to 6 Bev with a mean value of about 4 Bev. For the energy range 1 to 6 Bev, the production of strange particles occurs in about 1% of all inelastic interactions of neutrons with hydrogen and carbon. (auth)

### 3944

ANALYTIC PROPERTIES OF TRANSITION AMPLITUDES IN PERTURBATION THEORY. Stanley Mandelstam (Univ. of California, Berkeley). *Phys. Rev.* **115**, 1741-51 (1959) Sept. 15.

The analytic properties of two-particle transition amplitudes as functions of both energy and momentum transfer are examined in perturbation theory. The modified Nambu representation is discussed in a little more detail. It is shown that, as long as the masses do not satisfy certain inequalities connected with the existence of anomalous thresholds, the fourth-order terms, calculated in the usual manner, satisfy the representation. The spectral functions are calculated explicitly for spinless particles. The proof can be extended to the sixth order, but is not worked out here. The modifications necessary when there exist anomalous thresholds are mentioned. (auth)

### 3945

PROPOSAL FOR DETERMINING THE ELECTRO-MAGNETIC FORM FACTOR OF THE PION. William R. Frazer (Univ. of California, Berkeley). *Phys. Rev.* **115**, 1763-4 (1959) Sept. 15.

The possibility of measuring the electromagnetic form factor of the pion by extrapolation of the cross section for  $e^- + p \rightarrow n + \pi^+ + e^-$  was investigated. The method is based on the existence of a pole in the pion-electroproduction scattering amplitude as a function of the invariant momentum-transfer of the nucleon. The residue of this pole is the pion form factor multiplied

by a known coefficient. Since the pole lies slightly outside the physical region of the invariant momentum transfer, an extrapolation of the experimental data is required. An approximate calculation of the pion electroproduction cross section was made in order to estimate the experimental accuracy necessary for a significant extrapolation. Accuracy is required which is an order of magnitude better than that achieved at present in similar experiments. (auth)

### 3946

TEST OF GLOBAL SYMMETRY IN  $K^-$ -p REACTIONS. Marc H. Ross and Gordon L. Shaw (Indiana Univ., Bloomington). *Phys. Rev.* **115**, 1773-7 (1959) Sept. 15.

A method of testing the hypothesis that there is global symmetry of the pion-baryon interaction is proposed. Upon analyzing low-energy  $K^-$ -p scattering data, a variety of scattering length solutions were found which are compatible with the elastic scattering, charge exchange scattering, and total charged hyperon production. The method involves the use of the experimental  $\Sigma^+/\Sigma^-$  ratios to test the global symmetry hypothesis (or any other quantitative description of the pion-hyperon interaction), to reduce the ambiguity in the  $\bar{K}$ -N scattering length solutions, hence, to predict the  $\Sigma^0$  cross section. If there is global symmetry of pion-baryon interactions, then the  $\pi$ -Y phases in the absence of a  $\bar{K}$ -N reaction channel. It is shown how the actual  $\pi$ -Y phase shifts can be obtained, in a nonperturbative manner, from idealized  $\pi$ -Y phases (i.e., in the absence of  $\bar{K}$ -N reactions) and the  $\bar{K}$ -N scattering lengths. Earlier proposals making use of the dependence of the hyperon production ratios on the  $\pi$ -Y phase shifts are also examined in terms of this result. Certain fits to the present rough data with scattering lengths of negative real part are shown to be incompatible with global symmetry. The proposed analysis involves the assumption that the  $\bar{K}$  is an isotopic doublet. (auth)

### 3947

ANGULAR DISTRIBUTION OF NEUTRONS FOLLOWING THE NUCLEAR CAPTURE OF POLARIZED MUONS. A. Astbury, I. M. Blair, M. Hussain, M. A. R. Kemp, H. Muirhead, and R. G. P. Voss (Univ. of Liverpool). *Phys. Rev. Letters* **3**, 476-8 (1959) Nov. 15.

The angular distribution of neutrons following the nuclear capture of polarized mesons ( $\mu^-$ ) in  $S^{32}$  was determined for the process:  $\mu^- + p \rightarrow n + \nu$ . The ( $\mu^-$ ) lifetime in  $S^{32}$  was determined to be  $0.46 \pm 0.05$   $\mu$ sec. (C.J.G.)

### 3948

PION MASS MEASUREMENTS USING NEUTRON TIME-OF-FLIGHT TECHNIQUES. Roy P. Haddock, Alexander Abashian, Kenneth M. Crowe, and John B. Czirr (Univ. of California, Berkeley). *Phys. Rev. Letters* **3**, 478-80 (1959) Nov. 15.

Using neutron time-of-flight techniques, the  $\pi^-$  mass was determined to be  $272.4 \pm 1.1$  and the mass difference of  $\pi^-$  and  $\pi^0$  to be  $8.991 \pm 0.020$   $m_e$ . These values agree favorably with determinations by other groups. (C.J.G.)

### 3949

STRANGENESS 2 MESON. T. Yamanouchi (Univ. of Rochester, N. Y.). *Phys. Rev. Letters* **3**, 480-2 (1959) Nov. 15.

The existence of a D-particle is interpreted from several anomalous events observed by different groups. The values given for the mass of the D-particle vary from 640 to 750 Mev. (C.J.G.)

### 3950

RECENT REPRESENTATIONS OF THE ELECTRON. D. I.

Blokhintsev (Joint Inst. of Nuclear Research, Dubna, USSR). *Priroda* 48, No. 9, 25-9(1959) Sept. (In Russian)

An analysis is made of the existing data on electron structure. (R.V.J.)

### 3951

VACUUM POLARIZATION DUE TO CHARGED BOSONS. J. G. Gilson (Chelsea Coll. of Science and Tech., London). *Proc. Phys. Soc. (London)* 74, 480-1(1959) Oct. 1.

The vacuum polarization effect of the electron-positron field is calculated using a charged boson field polarization effect. The complicated interaction Hamiltonian for the boson did not complicate the procedure due to the choice of a simple external field. This method is similar to the method of Euwema and Wheeler. The convergence factor introduced in the Euwema and Wheeler method was found unnecessary by renormalizing the complex dielectric constant as a whole and not just its real component. (C.J.G.)

### 3952

A MEASUREMENT OF THE SPIN CORRELATION COEFFICIENT  $C_{nn}$  IN p-p SCATTERING AT 320 Mev, for 90° CENTRE OF MASS SCATTERING ANGLE. J. V. Allaby, A. Ashmore, A. N. Diddens, and J. Eades (Univ. of Liverpool). *Proc. Phys. Soc. (London)* 74, 482-3(1959) Oct. 1.

The spin correlation coefficient  $C_{nn}$  in (p, p) scattering at 320 Mev was determined to be  $0.75 \pm 0.11$  for a 90° center-of-mass scattering angle. (C.J.G.)

### 3953

ELEMENTARY PARTICLES. PART I. OLD PARTICLES. PART II. NEW PARTICLES. Ch. Manneback (Université, Louvain, Belg.). *Rev. questions sci. (Belg.-France)* 20, 321-48; 29-63(1958-59) July-Jan. (In French)

A review is presented of knowledge on "old" and new elementary particles, the "old" ones being p, n, e,  $e^+$ , mésons  $\mu$ , mesons  $\pi$ ,  $\nu$ , and  $\gamma$ , and the new ones, discussed in part II, being heavy K mesons and heavy nucleons. (T.R.H.)

## Nuclear Properties and Reactions

### 3954 ISC-1173

Ames Lab., Ames, Iowa. THE DETERMINATION OF PHOTONEUTRON THRESHOLDS. William S. Rawls and L. J. Laslett. Mar. 1959. 96p. Contract W-7405-eng-82. OTS.

The photoneutron thresholds of twelve nuclides were measured, using the delayed neutron detection method, in which four proportional neutron counters were embedded in a paraffin neutron house. A delayed electronic gate permitted neutrons to be detected during a 600-microsecond interval beginning 50 microseconds after beam extraction. The synchrotron beam intensity was measured by a transmission ionization chamber placed in the path of the synchrotron beam, and by the Newkirk method in which the photoneutron yield from the sample during alternate cycles of the machine, at some fixed reference energy setting, acted as the monitor. A calibration curve for the energy control device (integrator) to convert integrator settings into electron momenta was obtained, using measured thresholds of deuterium,  $Li^7$ , La, Pr,  $Cu^{65}$ , Mn,  $Cu^{63}$ , and Al, together with their respective last neutron binding energies as calculated from precision mass data. A modified calibration curve was drawn, for which the integrator setting and associated electron momentum at injection time provided an additional calibration point. This modified calibration curve was judged to be more reliable than the first curve because the injector voltage could be determined with good absolute accuracy and the location of the

corresponding point was particularly favorable to improve the accuracy on the lower portion of the calibration curve. The measured thresholds of vanadium, yttrium, and phosphorus were studied, and spin and parity selection rules employed in an attempt to identify the breaks as due to ground state transitions or as due to transitions to excited nuclear levels. In some cases it is apparent that a true threshold might be overlooked experimentally when the corresponding transitions are suppressed, and an apparent threshold results from transitions to an excited state. The threshold of bismuth was measured, using the calibration curves, and a threshold value of  $7.40 \pm 0.05$  Mev (standard error) was assigned to this element. (auth)

### 3955 NDA-2111-2

Nuclear Development Corp. of America, White Plains, N. Y. FAST NEUTRON CROSS SECTIONS OF IRON, SILICON, ALUMINUM, AND OXYGEN. Quarterly Progress Report No. 2 Covering Period April 15, 1959-July 15, 1959. E. A. Troubetzkoy. July 31, 1959. 10p. Contract DA-18-108-405-CML-295.

Progress is reported on the compilation of neutron cross section data for iron, silicon, aluminum, and oxygen. Preliminary data on angular distribution for three heavier elements are included. (auth)

### 3956 NYO-2846

Rochester, N. Y. Univ. STRIPPING REACTIONS AND THE STRUCTURE OF LIGHT AND INTERMEDIATE NUCLEI. M. H. Macfarlane and J. B. French. Oct. 19, 1959. 414p. Contract AT(30-1)-875. OTS.

A reduced width connecting two nuclear levels contains information about the structure of the states involved. Techniques are described whereby such information can be cast into useable form; the formalism so developed is then applied to an analysis of stripping widths. The various kinds of information about the structure of nuclei which can be obtained from an analysis of stripping widths are reviewed and what is known about the single-particle reduced widths is collected and summarized. A number of experiments of particular interest for future study are discussed. (W.D.M.)

### 3957 AEC-tr-3913

FISSION CROSS SECTIONS OF  $U^{233}$  AND  $U^{235}$  FOR NEUTRONS WITH ENERGY FROM 3 TO 800 kev. G. V. Gorlov, B. M. Gokhberg, V. M. Morozov, G. A. Otroshchenko, and V. A. Shigin. Translated by Lydia Venters (Argonne National Lab.) from *Atomnaya Energ.* 6, 453-7 (1959). 9p. JCL or LC.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, as abstract No. 13888.

### 3958 AEC-tr-3914

ANGULAR ANISOTROPY AND ENERGY CHARACTERISTICS OF THE FISSION PROCESS. A. N. Poropopov, I. A. Baranov, and V. P. Eismont. Translated by Lydia Venters (Argonne National Lab.) from *Zhur. Eksptl'. i Teoret. Fiz.* 36, 1608-9(1959). 3p. JCL or LC.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, abstract No. 16523.

### 3959 AEC-tr-3915

DEPENDENCE OF THE DEGREE OF ANGULAR ANISOTROPY OF FISSION PROCESS ON THE STRUCTURE OF NUCLEUS. A. N. Protopyov and V. P. Eismont. Translated by Lydia Venters (Argonne National Lab.) from *Zhur. Eksptl'. i Teoret. Fiz.* 36, 1573-4(1959). 4p. JCL or LC.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, abstract No. 16514.



**3960** NP-tr-317

NUCLEAR ISOMERISM AND ATOMIC SPECTRA. [PART] I. R. Weiner. Translated from *Acad. rep. populare Romîne, Inst. fiz. atomică și Inst. fiz. Studiî cercetări fiz.* 7, 567-77(1956). 15p. JCL.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, as abstract No. 12932.

**3961** NP-tr-318

QUASI-ELASTIC SCATTERING OF FAST NUCLEONS BY LIGHT NUCLEI. INFLUENCE OF A COMPLEX POTENTIAL. N. Bessis. Translated by S. Fitzgerald from *Compt. rend.* 248, 2168-70(1959). 6p. JCL.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, as abstract No. 12880.

**3962**

STUDY OF THE DE-EXCITATION OF  $\text{Ir}^{192}$  BY MEASUREMENTS OF BETA-GAMMA DIRECTIONAL CORRELATION. J. P. Deutsch, G. Doumont, and P. C. Macq (Université, Louvain, Belg.). *Ann. soc. sci. Bruxelles, Sér. III*, 2, 192-7(1958). (In French)

Directional correlation measurements on  $\text{Ir}^{192}$  beta-gamma cascades fix the angular momentum of the  $\text{Ir}^{192}$  ground state at 5. This determination method does not use controversial results of gamma-gamma directional correlation measurements on  $\text{Pt}^{192}$ . (auth)

**3963**

A SEARCH FOR LEVELS OF  $^7\text{Li}$  BETWEEN 9.0 and 9.55 Mev EXCITATION. K. H. Purser (Australian National Univ., Canberra). *Australian J. Phys.* 12, 231-6(1959) Sept.

The cross section of the reaction  $\text{Li}^6(n, \text{H}^3)\text{He}^4$  was measured with good energy resolution over the neutron range 2.0 to 2.65 Mev. This corresponds to an excitation of  $\text{Li}^7$  from 9.0 to 9.55 Mev, a region in which photodisintegration experiments indicate the presence of one or more levels. No resonance structure was observed and possible reasons for this are discussed. (auth)

**3964**

SCATTERING OF HIGH ENERGY POLARIZED NUCLEONS BY COMPLEX NUCLEI. B. A. Robson (Univ. of Melbourne). *Australian J. Phys.* 12, 248-57(1959) Sept.

The elastic scattering of 220 Mev polarized nucleons by carbon and calcium is studied. Except at small angles of scattering, substantial agreement is obtained with the results of calculations using a simplified form of the WKB method. Optical model parameters are found which are compared with those obtained by other workers for this energy region. (auth)

**3965**

SPINS AND PARITIES OF LEVELS OF  $^9\text{Be}$  BELOW 15 MEV. H. H. Thies and B. M. Spicer (Univ. of Melbourne). *Australian J. Phys.* 12, 293-6(1959) Sept.

Spin and parity assignments are made for the 1.7, 2.43, 3.05, 4.8, 6.8, 7.94, 9.2, 11.3, and 13.3 Mev levels in  $\text{Be}^9$  which were determined by other workers. (C.J.G.)

**3966**

EXCITED LEVELS OF  $^{50}_{88}\text{Sn}^{116}$ . A. Jones and M. De Croes (Université, Louvain, Belg.). *Bull. classe sci., Acad. roy. Belg.* 44, 780-6(1958). (In French)

The conversion coefficient ratios K/L were measured for the 0.406 and 0.137 Mev  $\gamma$  transitions. Coincidences between the 0.870 Mev  $\beta$  and the 0.406 Mev  $\gamma$  were investigated. New angular correlation measurements between the 0.406 and the 2.090 Mev  $\gamma$  rays emitted by an aqueous solution of  $\text{InCl}_3$  are in agreement with results already obtained with solid In sources. (auth)

**3967**

SOME OBSERVATIONS ON NUCLEAR ALIGNMENT IN COBALT METAL. J. M. Daniels and M. A. R. LeBlanc (Univ. of British Columbia, Vancouver). *Can. J. Phys.* 37, 1321-4(1959) Nov.

A piece of cobalt metal single crystal was irradiated to an activity of  $\sim 3 \mu\text{c}$  and cooled to 0.04°K. Calculations using measured values of specific heat for the constant (a) which describes the hyperfine coupling of the nucleus with the electron spins give  $a = 1.4 \times 10^{-4}$  for  $\text{Co}^{59}$  and  $\text{Co}^{60}$ , respectively. The difference in the value of (a) obtained with that obtained by other workers might be explained that this crystal contained more of the hexagonal phase before heat treatment than after and consequently that the hyperfine coupling in the cubic phase is much less than in the hexagonal phase. (C.J.G.)

**3968**

NUCLEAR SPIN RELAXATION IN LOW-TEMPERATURE LIQUIDS. Irwin Oppenheim and Myer Bloom (Univ. of British Columbia, Vancouver). *Can. J. Phys.* 37, 1324-7(1959) Nov.

The interpretation of nuclear spin lattice relaxation time measurements in low-temperature liquids is discussed. The relaxation mechanisms of atomic and molecular liquids are considered. (C.J.G.)

**3969**

LIFETIME OF THE  $6^3\text{P}_1$  EXCITED STATE OF MERCURY VAPOR FOR THE ISOTOPES WITH EVEN AND ODD MASSES. Jean-Louis Cojan and Michel Thibau. *Compt. rend.* 249, 1489-91(1959) Oct. 15. (In French)

The measurement of the absorption of a parallel light beam from a resonance lamp by an absorption tube filled with mercury vapor leads to the determination of the lifetime of the  $6^3\text{P}_1$  excited state of mercury. The same value ( $\lambda = 1.16 \times 10^{-7}$  sec) was found for all the isotopes of mercury. (tr-auth)

**3970**

THE ANGULAR DISPERSION OF PARTICLE BEAMS PASSING THROUGH NUCLEAR EMULSIONS. Brigitte Chemel and Tsai-Chü. *Compt. rend.* 249, 1494-6(1959) Oct. 19. (In French)

The measurement of the angular dispersion of a 6-Bev proton beam and a 300-Mev  $\pi$  meson beam has permitted the determination of the vector of deformation and the multiple scattering constant. The scattering constant approaches an upper limit for particles of high velocity. (tr-auth)

**3971**

THE ELASTIC SCATTERING OF NEGATIVE PIONS OF 745 Mev/c ON HYDROGEN. Jean-Marc Gaillard, Pierre Lehmann, Antoine Lévêque, João Meyer, Daniel Revel, and Jean Sacton. *Compt. rend.* 249, 1497-9(1959) Oct. 19. (In French)

The  $\pi^- - p$  differential cross section was measured on the second resonance (pions of 745 Mev/c). The total elastic cross section is  $20 \pm 3$  mb. (tr-auth)

**3972**

THE DISINTEGRATION OF  $\text{Se}^{81\text{m}}$ . Christian Ythier, Jean de Beauregard, Pierre Paris, and Georges Ambrosino. *Compt. rend.* 249, 1500-01(1959) Oct. 19. (In French)

The decay of  $\text{Se}^{81\text{m}}$  obtained from  $\text{Br}(n, p)$  reactions, was studied. The scintillation spectrum had an intense peak at  $101 \pm 3$  kev, which was caused by the isomeric transition. A much weaker peak was detected at  $285 \pm 9$  kev. Indications were obtained of the presence of other still weaker gamma rays. The relative intensities of the 101 and 285 kev lines are of the order of 100 and  $15 \pm 5$ . The gamma

and beta radiation decay with a period of  $61 \pm 2$  min. The possible levels of  $\text{Br}^{81}$  to which the  $\text{Se}^{81m}$  decays are discussed. (J.S.R.)

### 3973

HALF LIFE OF THE 402-keV LEVEL OF ARSENIC-75. Michel Vergnes. *Compt. rend.* **249**, 2057-9(1959) Nov. 16. (In French)

The half life of the 402-keV level of  $\text{As}^{75}$  was measured by the delayed coincidence method. The value  $T_{1/2} = 1.8 \pm 0.4 \times 10^{-8}$  sec was obtained in good agreement with previous results. (J.S.R.)

### 3974

COLLISIONS OF AN ELECTRON WITH A HYDROGEN ATOM. Max Morand, Marie-Cécile Lefèvre Le Gentil, and Simone Desprez-Rebaud. *Compt. rend.* **249**, 2060-1(1959) Nov. 16. (In French)

The variation of the cross section for the ejection of an electron from the hydrogen atom by collision with an electron of given energy was studied by utilizing the classical and quantum theories. The results obtained by the two methods for incident electrons of 1 and 50 keV energy are tabulated and compared. (J.S.R.)

### 3975

EFFECTIVE CROSS-SECTIONS AND THE ANISOTROPY OF  $\text{Np}^{237}$  AND  $\text{Th}^{230}$  FISSIONS. B. M. Gochberg, G. A. Otroschenko, and V. A. Shigin. *Doklady Akad. Nauk S.S.S.R.* **128**, 1157-9(1959) Oct. 21. (In Russian)

The cross section and anisotropic fission of  $\text{Np}^{237}$  and  $\text{Th}^{230}$  were measured at the threshold. The dependence of the fission cross sections and the differential cross sections of  $\text{Np}^{237}$  and  $\text{Th}^{230}$   $\sigma_f(0^\circ)$ ,  $\sigma_f(90^\circ)$ , on neutron energies are shown graphically. The anisotropy of  $\text{Np}^{237}$  fission (due to the small dimensions of effective cross sections) was measured starting with 350 keV neutrons. The lack of data on the isotopic composition of  $\text{Th}^{230}$  prevented measurements above 12,000 keV at which point admixture of  $\text{Th}^{232}$  appears. (R.V.J.)

### 3976

ALPHA SPECTRA OF  $\text{U}^{233}$ . B. S. Dzhelepov, R. B. Ivanov, V. G. Nedovesov, and B. P. Shishin (Khlopin Radium Inst., Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.* **23**, 788-91(1959) July. (In Russian)

The decay scheme for  $\text{U}^{233}$  was developed using the data on  $\alpha$  lines;  $\alpha_0 - 4816$  keV (83.5%),  $\alpha_1 - 4773$  keV (14.9%),  $\alpha_2 - 4717$  keV (1.6%),  $\alpha_3 - 4655$  keV (0.07%),  $\alpha_4 - 4582$  keV (0.04%), and  $\alpha_5 - 4489$  keV (0.03%). According to this scheme all excited states of the  $\text{Th}^{229}$  nucleus are of a rotational nature and belong to the band with  $K = 5/2$ . The intensity ratio of the last three lines (0.07, 0.04, and 0.03%) are not in good agreement with the existing formulas for  $\alpha$ -transition intensities. The  $\alpha$ -decay scheme of  $\text{U}^{233}$  and  $\text{Th}^{229}$  levels are shown graphically. (R.V.J.)

### 3977

COLLECTIVE EXCITATION STATES OF ATOMIC NUCLEI. A. S. Davydov. *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.* **23**, 792-811(1959) July. (In Russian)

The axial symmetry hypothesis for all nuclei is not confirmed by experimental data. Various phenomena related to small excitation state of even-even nuclei can be explained by assuming that the nuclear shape can be approximated by a triaxial ellipsoid. Rotational states of even-even non-axial nuclei are studied and compared with experimental data. Data on the probability of electromagnetic transitions between rotational states of non-axial nuclei and on the probability of  $\beta$  decays into variable rotational states are discussed. Results of published theoretical data postulating

that equilibrated nuclear shape may not possess axial symmetry are reviewed. (R.V.J.)

### 3978

CONVERSION ELECTRONS OF  $\text{Yb}^{166}$  AND  $\text{Tm}^{166}$ . V. Brabets, K. Ya. Gromov, B. S. Dzhelepov, A. G. Dmetriev, and V. A. Morozov (Khlopin Radium Inst. Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.* **23**, 812-18(1959) July. (In Russian)

A magnetic  $\beta$  spectrometer with improved focusing was used in studies of electron conversion spectra appearing

in the chain  $\text{Yb}^{166} \xrightarrow[60 \text{ hr}]{K} \text{Tm}^{166} \xrightarrow[7.7 \text{ hr}]{K} \text{Er}^{166}$  stable. The resolving power was 0.5% and light power  $\sim 0.4\%$ . Isotopes of  $\text{Yb}^{166}$  and  $\text{Tm}^{166}$  were obtained from deep spallation produced in tantalum by 660 MeV proton bombardment. (R.V.J.)

### 3979

$\gamma$  SPECTRA OF  $\text{Tm}^{166}$  AND  $\text{Yb}^{166}$ . V. I. Baranovskii and V. N. Pokrovskii (Joint Inst. of Nuclear Research, Dubna). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.* **23**, 819-20(1959) July. (In Russian)

The scintillation methods were used in studies of members of the genetic chain of  $\text{Yb}^{166} \rightarrow \text{Tm}^{166} \rightarrow \text{Er}^{166}$  produced in deep spallation of Ta by 660 MeV protons. The data were used in a detailed tabulation of the energy and intensity of  $\text{Tm}^{166}$   $\gamma$  lines. The order of error of  $\gamma$  intensities was from 10 to 20%. The complexity of the spectrum prevented the determination of intensities in the range 280 to 400 keV, however, it was found that the intensities of these transitions are smaller by the order of one than the transition intensity of  $\text{Er}_\gamma - 184$  keV. (R.V.J.)

### 3980

DECAY SCHEME OF  $\text{Tm}^{166}$ , MULTIPLICITY OF  $\text{Er}^{166}$  TRANSITIONS. K. Ya. Gromov, B. S. Dzhelepov, and V. N. Pokrovskii (Khlopin Radium Inst., Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.* **23**, 821-5(1959) July. (In Russian)

Tabulated data enumerate the energies of  $\gamma$  transitions identified in studies of conversion electron spectra. Intensities of  $\gamma$  rays are selected so that the internal conversion coefficients of the K and L shells for 80 keV  $\gamma$  transitions correspond to theoretical transitions of the E2 type. The multiplicity of various transitions on the K shell was determined by comparing coefficients of internal conversion with theoretical data. The experimental magnitude of  $\alpha_K$  transitions at 183.9 keV coincide with the theoretical data for E2 type transitions. The multiplicity of 214.1 keV transitions is defined as single sign E1. The transitions of 459 and 596 keV are probably of the same type. The coefficients of internal conversion transitions 1181, 1277, 1380, and 1878 keV satisfactorily coincide with the theoretical E2 type. The multiplicity of these transitions is either E2 or  $M1 + E2$ . The obtained data verified the  $\text{Tm}^{166}$  decay scheme. The first and second rotational level lines of  $\text{Er}^{166}$  are presented. Further measurements of conversion electron energies and experiments with coincidences are suggested in order to clarify the sequences of  $\text{Er}^{166}$  high excitation states and their quantum characteristics. (R.V.J.)

### 3981

$\gamma$  RADIATION OF  $\text{Cs}^{134}$ . B. S. Dzhelepov, V. P. Prikhodtseva, and Yu. V. Khol'nov (Khlopin Radium Inst., Academy of Sciences, USSR). *Izvest. Akad. Nauk S.S.S.R., Ser. Fiz.* **23**, 826-7(1959) July. (In Russian)

A magnetic spectrometer with recoil electrons was used for measuring the  $\text{Cs}^{134}$   $\gamma$  spectrum in order to correct and verify relative intensities of  $\gamma$  lines. The weak  $\gamma$  lines were studied with an electron at 820 keV. The energies and in-



tensities and the electron recoil spectra obtained with a rittatron and elotron are tabulated and plotted. (R.V.J.)

### 3982

$\gamma$  RADIATION OF  $Ta^{182}$  AT 300 TO 1500 kev. N. A. Voinova, B. S. Dzhelepov, and N. N. Zhukovskii (Khlopin Radium Inst., Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 828-30(1959) July. (In Russian)

The gamma radiation of  $Ta^{182}$  was studied with an elotron in order to verify the intensities of  $\gamma$  lines and to seek new lines in the vicinity of 300 to 1500 kev. Neutron activated tantalum foil weighing 1.18g was used as the source. Experimental spectral curves for electron recoil from a polystyrene target are plotted and the region at 850 to 1350 kev is divided by components into 7  $\gamma$  lines of 927, 960, 1003, 1122, 1192, 1222, and 1231 kev. (R.V.J.)

### 3983

SPECTRA OF NEUTRON-DEFICIENT Hf ISOTOPES. V. I. Baranovskii and A. V. Kalyamin (Khlopin Radium Inst., Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 831(1959) July. (In Russian)

Scintillation methods were used in studies of the Hf fraction isolated from Ta irradiated by 680 Mev protons. Two lines of 125 and ~300 kev with the intensity ratio 100:60 were found for  $Hf^{173}$  (with  $T_{1/2} = 23.5$  hours). For  $Hf^{171}$  ( $T_{1/2} = 13$  hours), a group of lines at 400 to 700 kev was uncovered in addition to the known line of 175 kev. The  $Hf^{171}$  spectrum was divided into separate components and their relative intensities tabulated. The half life of the 175 kev line was ~16 hours, which indicates the presence of  $Hf^{173}$  (162.3 kev) and  $Lu^{171}$  (180 kev; with  $Lu^{171}$  accumulated as the result of the decay of  $Hf^{171}$ ). (R.V.J.)

### 3984

ON THE HARD SECTION OF RADIUM  $\gamma$  SPECTRUM IN EQUILIBRIUM WITH THE PRODUCTS OF DECAY ( $h\nu = 3100$  TO 5600 kev). B. S. Dzhelepov, B. A. Emil'yanov, Yu. N. Podkopaev, V. N. Podymakhin, I. F. Uchevatkin, and S. A. Shestopalova (Zhdanov Leningrad State Univ.). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 832-4(1959) July. (In Russian)

A highly sensitive  $\gamma$  hodoscope was used for measuring hard  $\gamma$  rays from a Ra source. The measurements were taken at 3070 to 5600 kev. The plotted diagrams show an excess of recoil electrons behind the "hard drop" of the 3070 kev line extending up to 3800 kev, while the other measurements show an excess of recoil electrons in the region of 3500 to 3800 kev. It is assumed that the latter condition is produced by  $\gamma$  rays from the transition  $RaC''$   $RaD$ . Both diagrams indicate the presence of the 3100 to 3200 kev  $\gamma$  line. The  $E_\gamma \sim 3200$  kev can appear in  $RaC \rightarrow RaC'$  decay or in  $RaC'' \rightarrow RaD$  transition. The  $E_\gamma < 3900$  kev was not observed; should it exist, its intensity must be less than  $5 \times 10^{-8}$  quantum per decay. (R.V.J.)

### 3985

STUDIES OF LOW-ENERGY LEVELS OF  $Cl^{33}$  BY MEANS OF  $S^{32}(p, \gamma) Cl^{33}$  REACTION. A. K. Val'ter, V. Yu. Goncharov, A. N. L'vov, and S. P. Tsytiko (Inst. of Physics and Tech., Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 835-8(1959) July. (In Russian)

An explanation is derived for the contradicting data published on the even parity of the 2.9 level of  $Cl^{33}$ , and an attempt was made to establish a relationship between the mirror nuclei  $S^{33}$  and  $Cl^{33}$  at the 2.9 Mev excitation level. (R.V.J.)

### 3986

ELASTIC SCATTERING AND RADIATIVE CAPTURE OF PROTONS BY  $N^{14}$  NUCLEI. A. K. Val'ter, A. S. Deinenko,

P. V. Sorokin, and A. Ya. Taranov (Inst. of Physics and Tech., Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 839-45(1959) July. (In Russian)

Proton capture and elastic scattering cross sections for  $N^{14}$  at 1.7 to 3.5 Mev were studied and energy levels for  $O^{15}$  at 7 Mev are determined. (R.V.J.)

### 3987

ELASTIC SCATTERING OF PROTONS BY  $Ar^{40}$ . A. K. Val'ter, I. Ya. Malakhov, P. V. Sorokin, and A. Ya. Taranov (Inst. of Physics and Tech., Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 846-8(1959) July. (In Russian)

Cross sections for proton elastic scattering by  $Ar^{40}$  are measured at 90, 125, and 150° angles in the cm system at 1.7 to 2.7 Mev and energy levels of  $K^{41}$  at 8 Mev are determined. (R.V.J.)

### 3989

ON  $Ga^{67}$  AND  $Ga^{68}$  EXCITATION STATES. A. K. Val'ter, I. I. Zalyubovskii, V. A. Klyucharev, and V. A. Lutsik (Inst. of Physics and Tech., Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 849-54(1959) July. (In Russian)

A scintillation  $\gamma$  spectrometer was used in studies of  $\gamma$  radiation emitted in  $Zn^{66}(p, \gamma) Ga^{67}$ ;  $Zn^{67}(p, n\gamma) Ga^{67}$ ; and  $Zn^{67}(p, \gamma) Ga^{68}$  reactions at proton energies ranging from 1.6 to 3.4 Mev. (R.V.J.)

### 3989

FINE STRUCTURE OF  $Th^{229} \alpha$  SPECTRUM. G. E. Kocharov, A. P. Komar, G. A. Korolev, I. N. Marov, and Yu. A. Surkov (Inst. of Physics and Tech., Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 855-8(1959) July. (In Russian)

A high-resolving power, ionization  $\beta$  spectrometer was used for studying the energy spectra of  $Th^{229} \alpha$  particles. The investigated  $U^{233}$  contained  $Th^{229}$  in addition to  $Th^{229}$ . The well known  $\alpha$  lines and daughter nuclei of  $Th^{229}$  were utilized for determining the energies of unknown  $\alpha$  lines. The obtained energies and relative intensities for thorium  $\alpha$  lines are tabulated and the decay scheme of  $Th^{229}$  is presented. (R.V.J.)

### 3990

CONVERSION ELECTRON COINCIDENCES IN THE  $Se^{75} \rightarrow As^{75}$  DECAY. V. E. Bunakov, B. S. Dzhelepov, I. Zvol'skii, and V. A. Sergienko (Zhdanov Leningrad State Univ.). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 859-63(1959) July. (In Russian)

A double lens  $\beta$  spectrometer was used in studies of conversion electron coincidences in  $Se^{75} \rightarrow As^{75}$  ( $T = 127$  days).  $Se^{75}$  was prepared by  $(n, \gamma)$  reactions in enriched  $Se^{74}$ . Coincidences between conversion electrons K-136 and 66, K-136 and 265, K-121 and 280, K-199 and 66, K-199 and 66.5 + 81 were observed and tabulated. The results verify previously published data on coincidences between  $\gamma$  transitions and confirm the suggested decay scheme for  $Se^{75}$ . (R.V.J.)

### 3991

ON TRANSITIONS OF  $Er^{160} \rightarrow Ho^{160}$  AND  $Yb^{166} \rightarrow Tu^{166}$ . E. P. Grigor'ev, B. S. Dzhelepov, and A. V. Zolotavin (Zhdanov Leningrad State Univ.). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 864-7(1959) July. (In Russian)

Certain peculiarities in the primary transitions  $Er^{160} \rightarrow Ho^{160}$  and  $Yb^{166} \rightarrow Tu^{166}$  and possible corresponding decay scheme variations are studied. (R.V.J.)

### 3992

THE  $Ho^{160}$  DECAY AND  $Dy^{160}$  ENERGY LEVELS. E. P. Grigor'ev, B. S. Dzhelepov, A. V. Zolotavin, B. Kratsik,

and G. Bitterlikh (Zhdanov Leningrad State Univ.). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 868-74(1959) July. (In Russian)

$\text{Ho}^{160}$  decay was analyzed in order to show that the  $\text{Ho}^{160} \rightarrow \text{Dy}^{160}$  decay results in  $\text{Dy}^{160}$  with energy levels up to 2900 kev. 55 new conversion lines were found and intensities for the previously reported conversion lines were either verified or corrected. The  $\text{Dy}^{160}$  energy level schemes are developed and expanded. Several new transitions between the known  $\text{Dy}^{160}$  levels were uncovered as well as several previously unknown higher energy levels. (R.V.J.)

### 3993

ON THE CALCULATION OF THE REDUCED LIFETIME OF ft NUCLEI FOR UNIQUE  $\beta$  TRANSITIONS. L. N. Zyryanova (Zhdanov Leningrad State Univ.). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 875-9(1959) July. (In Russian)

Numerical values are derived for the Fermi  $f_n^{\text{un}}$  integral for  $\beta$  transitions of first and second forbiddance. (R.V.J.)

### 3994

ANGULAR CORRELATION OF  $\text{Ne}^{21}$   $\gamma$  RAYS. A. G. Khabakhpashev and E. M. Tsenter (Moscow Inst. of Physics Engineering). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 883-6(1959) July. (In Russian)

A scintillation counter with a  $40 \times 40$  mm NaI crystal was used for measuring the angular correlation of  $\text{Ne}^{21}$   $\gamma$  rays emitted from a Po-O source (reaction  $\text{O}^{18}(\alpha, n)\text{Ne}^{21}$  with  $\gamma$  quanta at 0.35 to 1.35 Mev). The number of coincidences at various angles between the source and counters was measured with a 50 channel analyzer. Measurements were made at 90, 120, 150, and 180° angles with the source intensity of  $10^5$  neutrons per second placed at the rotation axis of the second counter, 62 mm from each crystal. The results were developed by the method of least squares. The results of the angular correlation indicate the admixture E2 in the cascade transition  $\frac{1}{2} \rightarrow \frac{1}{2} \rightarrow \frac{3}{2}$  as 9%, for transition  $\frac{1}{2} \rightarrow \frac{1}{2} \rightarrow \frac{3}{2}$  as 11%, and for  $\frac{1}{2} \rightarrow \frac{1}{2} \rightarrow \frac{3}{2}$  as 2%. Measurements were also made of the first excitation level of  $\text{Ne}^{21}$  for determining the interaction effects of nuclear magnetic moments in intermediate shells. The obtained value was  $\tau = (1.0 \pm 1.1) \times 10^{-10}$  sec. (R.V.J.)

### 3995

CASCADE  $\gamma$  TRANSITIONS IN  $\text{Cl}^{36}$  AND  $\text{S}^{33}$  FOLLOWING THE CAPTURE OF THERMAL NEUTRONS. V. R. Burmistrov. *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 898-901 (1959) July. (In Russian)

Binary cascade transitions in  $\text{Cl}^{36}$  and  $\text{S}^{33}$  accompanying the capture of thermal neutrons were studied by the "coincidence summing" method using scintillation counters. An ordinary  $\gamma$ - $\gamma$  coincidence method was also used for measuring transitions in  $\text{S}^{33}$ . The decay scheme is included. Cascades obtained by the method of "coincidence summing" were 7.79-0.79; 7.42-1.16; 6.97-1.60; 6.64-1.95; 5.72-2.88 and 6.11-0.51-0.79. The decay scheme for  $\text{S}^{33}$  is also presented. Cascades of 7.8-0.84; 1.21-7.42; 1.64-7.02; 5.44-3.21 and 4.58-4.05 were plotted as well as 4.58-4.05 and 6.82-2.00, which are not sufficiently proven. The ordinary method permitted segregation of only two cascades: 7.8-0.84 and 1.21-7.42 Mev. (R.V.J.)

### 3996

CASCADE  $\gamma$  TRANSITIONS IN  $\text{Nd}^{144}$ . V. R. Burmistrov. *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* **23**, 902-9(1959) July. (In Russian)

The scheme of  $\text{Nd}^{144}$  energy levels was studied by  $\gamma$ - $\gamma$  coincidences. (R.V.J.)

### 3997

A PRELIMINARY LIST OF LEVELS AND g-VALUES FOR THE FIRST SPECTRUM OF THORIUM (Th I). Romuald Zalubas (National Bureau of Standards, Washington, D. C.). *J. Research Natl. Bur. Standards* **63A**, 275-8(1959) Nov.-Dec.

The present state of the analysis of the first spectrum of thorium (Th I) is discussed briefly. Even and odd levels are listed. The low even levels form terms arising from the configurations  $6d^2 7s^2$  and  $6d^3 7s$ . The Th I standard wavelengths that fit into the known level arrays are presented. (auth)

### 3998

NUCLEAR MOMENTS OF  $\text{Os}^{187}$ . Günther Guthöhrlein, Hans Kopfermann, Gerhard Nöldeke, and Andreas Steudel (Universität, Heidelberg, Ger.). *Naturwissenschaften* **46**, 598-9(1959) Nov.

The Os I lines at 4794 and 4261 Å were produced from  $\text{Os}^{187}$  (formed by  $\beta$ -decay of  $\text{Re}^{187}$ ) in a hollow-cathode source. A Fabry-Perot spectrometer revealed the fine structure. The nuclear rotation impulse quantum number was:  $I(\text{Os}^{187}) = \frac{1}{2}$ . The nuclear magnetic dipole moment was  $+ (0.065 \pm 0.003)$ . (T.R.H.)

### 3999

DECOMPOSITION OF THE PARTICLE AND CONNECTION OF PARTICLES IN THE TERMINI OF THE MOMENTUM SPACE. N. A. Chernikov. *Nauch. Doklady Vyssheĭ Shkoly Fiz. Mat. Nauki* No. 2, 158-61(1958).

Geometric and algebraic notions and ideas are used to obtain a geometric interpretation of the kinematics of nuclear reactions. Thus, extended analytic calculations combined with the transition from one reference system to another, are replaced by simple formulas of the hyperbolic trigonometry. Let a particle move with the velocity  $a$  in a reference system which moves with the velocity  $o$ . Then the modulus of the three-dimensional impulse of the particle is  $p_{oa} = m c \text{ sh } \overline{oa}/c$ , where  $m$  is the resting mass,  $c$  is the velocity of the light,  $\overline{oa}$  is the distance of the points  $o$  and  $a$  in the momentum space. The kinetic energy  $\epsilon_{oa}$  of the particle in the system  $o$  is  $\epsilon_{oa} = m c^2 [\overline{oa}/c - 1]$ . Then the ratio  $\epsilon_{oa}/m$  is the area divided by  $2\pi$  of a circle of radius  $oa$  in the momentum space. (TCO)

### 4000

THRESHOLD EFFECTS IN HIGH ENERGY REACTIONS. A. I. Baz (Atomic Energy Inst., Moscow). *Phil. Mag.* (8) **4**, 1035-45(1959) Sept.

The resonances which occur in high energy phenomena are interpreted in terms of threshold states. Definite indications were found for a resonance at  $\sim 0.9$  Bev in  $\pi^- + p$  scattering, a resonance at very low energies in  $k^- + p$  scattering, and a resonance at  $\sim 0.95$  Bev in the reaction  $\gamma + p \rightarrow \Lambda + K^+$ . Tentative conclusions are drawn regarding the parities of some of the elementary particles. (auth)

### 4001

THE INTERACTION RATES OF STOPPED NEGATIVE MUONS IN VARIOUS ELEMENTS. W. B. Gilboy and R. M. Tennent (Univ. of Leeds, Eng.). *Phil. Mag.* (8) **4**, 1055-62 (1959) Sept.

The lifetimes of negative muons brought to rest in a series of elements were measured. The mean lifetimes were found to be: Cr,  $(268 \pm 16)\text{ns}$ ; Mn,  $(261 \pm 14)\text{ns}$ ; Fe  $(205 \pm 14)\text{ns}$ ; Co,  $(196 \pm 11)\text{ns}$ ; Ni,  $(160 \pm 10)\text{ns}$ ; Cu,  $(168 \pm 7)\text{ns}$ ; and Zn,  $(151 \pm 13)\text{ns}$ . Using different assumptions, the various interaction rates were calculated and compared with the theories of Primakoff, and Tolhoek and Luyten. Measurements of the time delays in



Geiger counter discharges and photomultiplier after-pulses are described. (auth)

#### 4002

NUCLEAR SPIN RELAXATION IN LIQUID  $\text{He}^3$ . R. H. Romer (Duke Univ., Durham, N. C.). Phys. Rev. **115**, 1415-16(1959) Sept. 15.

The nuclear spin thermal relaxation time,  $T_1$ , of  $\text{He}^3$  nuclei was measured at 1.2 and 3.0°K in pure liquid  $\text{He}^3$  under its saturated vapor pressure. The measured times are those characteristic of the bulk liquid.  $T_1$  is 300 seconds at 1.2° and increases to 550 seconds at 3.0°K. These results are in fair agreement with the Bloembergen, Purcell, and Pound theory. For a 12% solution of  $\text{He}^3$  in  $\text{He}^4$  under its saturated vapor pressure,  $T_1$  is about 2000 seconds and does not show any sharp change at the lambda point. In pure  $\text{He}^3$  gas at 4.2°K and 1000 mm pressure,  $T_1$  is at least 1000 seconds. In dilute solutions at 1.25°K,  $T_1$  is at least 90 minutes for a 3.5% solution and at least 120 minutes for a 1.7% solution. (auth)

#### 4003

SELF-DIFFUSION AND NUCLEAR RELAXATION IN  $\text{He}^3$ . R. L. Garwin and H. A. Reich (Columbia Univ., New York). Phys. Rev. **115**, 1478-92(1959) Sept. 15.

Direct spin-echo measurements of diffusion coefficient (D) and spin relaxation time ( $T_1$  and  $T_2$ ) are performed on  $\text{He}^3$ , with an accuracy ~2% in the range 0.5 to 4.2°K and at pressures to 67 atm in liquid, solid, and in dilute solutions of  $\text{He}^3$  in  $\text{He}^4$ . Unactivated diffusion is observed to the lowest temperatures in the liquid, but not in the solid. By measurement of D at 19 atm an activation energy of 13.7°K was found for the production of scatterers in  $\text{He}^4$ . There is an extended discussion of experimental details. (auth)

#### 4004

PRECISE DETERMINATION OF NUCLEAR REACTION ENERGIES AND MEASUREMENTS OF RESONANCE WIDTHS. R. O. Bondelid and C. A. Kennedy (Naval Research Lab., Washington, D. C.). Phys. Rev. **115**, 1601-12(1959) Sept. 15.

An electrostatic analyzer with a radius of curvature of 2 meters and a deflection angle of 90° was constructed and evaluated. It is used to provide an ion beam whose energy is precisely known and highly resolved. The absolute energy calibration is believed to be accurate to  $\pm 0.05\%$ , and the inherent energy resolution is 0.01% per 0.010 in. of input slit separation. Proton bombarding energies were determined for (p, $\gamma$ ) reactions on  $\text{F}^{19}$  at  $340.5 \pm 0.3$  kev,  $483.6 \pm 0.3$  kev, and  $872.4 \pm 0.4$  kev;  $\text{Al}^{27}$  at  $992.4 \pm 0.5$  kev;  $\text{Ni}^{58}$  at  $1424.1 \pm 0.7$  kev, and  $1834.7 \pm 0.9$  kev; and  $\text{C}^{13}$  at  $1747.6 \pm 0.9$  kev. Resonance widths were measured for these reactions. They are  $2.4 \pm 0.3$  kev,  $0.9 \pm 0.1$  kev,  $4.5 \pm 0.3$ ,  $100 \pm 50$  ev,  $50 \pm 50$  ev,  $100 \pm 50$  ev, and  $75 \pm 50$  ev, respectively. The (p,n) thresholds were determined for  $\text{Li}^7$  at  $1881.2 \pm 0.9$  kev and  $\text{C}^{13}$  at  $3237.2 \pm 1.6$  kev. (auth)

#### 4005

LEVELS IN  $\text{Zr}^{90}$ : EXPERIMENTAL. S. Bjørnholm, O. B. Nielsen, and R. K. Sheline (Univ. of Copenhagen, Denmark). Phys. Rev. **115**, 1613-26(1959) Sept. 15.

The levels in  $\text{Zr}^{90}$  were studied by analyzing the radiations of  $\text{Nb}^{90}$  in magnetic and scintillation spectrometers employing various coincidence techniques. Multipolarities of most of the transitions were determined from internal conversion coefficients and K-L ratios. A decay scheme (I) for  $\text{Nb}^{90}$  is proposed which assigns the following excited states in  $\text{Zr}^{90}$ : 1752 kev (0+), 2182 kev (2+), 2315 kev (5-), 3081 kev (4+), 3453 kev (6+), and 3595 kev (8+). Evidence

is discussed for a few weak additional transitions potentially involving three additional levels (decay scheme II). Following the suggestion of Ford, the levels in decay scheme I are all interpreted as arising from the proton configurations  $(p_{3/2})^2$ ,  $(g_{7/2})^2$ , and  $(g_{7/2}p_{3/2})$ . The half-life of the 3595 kev 8+ state was experimentally determined as  $3 \times 10^{-7}$  sec, in good agreement with the half-life expected for a 141.5-kev E2 transition between 8+ and 6+ states, each involving a  $(g_{7/2})^2$  configuration. The relative population of the two 0+ states of  $\text{Zr}^{90}$ , both by de-excitation of the 2+ state of that nucleus and by the beta decay of  $\text{Y}^{90}$ , indicates that these states result from highly mixed  $(p_{3/2})^2$  and  $(g_{7/2})^2$  configurations. Hindrance factors for several transitions indicate that the other positive parity states are largely generated from the  $(g_{7/2})^2$  configuration. (auth)

#### 4006

LEVELS IN  $\text{Zr}^{90}$ : THEORETICAL. B. F. Bayman, A. S. Reiner, and R. K. Sheline (Univ. of Copenhagen, Denmark). Phys. Rev. **115**, 1627-35(1959) Sept. 15.

An attempt is made to describe the seven levels of  $\text{Zr}^{90}$  below 3.6 Mev in terms of the proton configurations  $(2p_{3/2})^2$ ,  $(2p_{3/2}1g_{7/2})$ , and  $(1g_{7/2})^2$ . The level positions and the compositions of the two 0+ states are determined for Gaussian and Yukawa forces of various ranges and exchange characters. The experimental data are well reproduced for a reasonable choice of the force parameters, the best fit being obtained with a Serber exchange mixture and a range of about 1.5 fermis. The experimental values of the half-lives of the excited states can also be reconciled with these simple configurational assignments. The most serious discrepancy is in the half-life of the first excited (0+) state, which we calculate to be  $1.35 \times 10^{-8}$  sec, as compared to the observed value of  $(6.0 \pm 1.5) \times 10^{-8}$  sec. The remaining discrepancies in the energies and half-lives are in the direction of the effects produced by a slight deformation of the  $\text{Sr}^{88}$  core. (auth)

#### 4007

ELASTIC SCATTERING OF  $\text{N}^{14}$  BY  $\text{Be}^9$ . M. L. Halbert and A. Zucker (Oak Ridge National Lab., Tenn.). Phys. Rev. **115**, 1635-42(1959) Sept. 15.

Nitrogen-beryllium elastic scattering was measured over an angular range from 32 to 144 deg in the center-of-mass system with an angular resolution of about one degree. The mean energy of the incident nitrogen ions was 27.3 Mev. To distinguish elastic scattering from other events, both the scattered and the recoil particles were detected in coincidence by thin  $\text{CsI(Tl)}$  scintillation counters. The elastic scattering differential cross section is 550 mb/sterad at 32 deg c.m. It decreases monotonically and more rapidly than  $\text{csc}^4(\theta/2)$  to a shallow minimum of about 5 mb/sterad at 106 deg c.m., rises slightly, and then falls to about 2.5 mb/sterad at 144 deg c.m., the largest angle measured. The data are compared to the predictions of a sharp-cutoff model for elastic scattering, but no agreement is found between this theory and the experimental results. (auth)

#### 4008

ELASTIC SCATTERING OF PROTONS BY NITROGEN. A. J. Ferguson, R. L. Clarke, and H. E. Gove (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev. **115**, 1655-9(1959) Sept. 15.

The cross sections for the elastic scattering of protons by nitrogen were measured in 105 angular distributions ranging in angle from 53° to 155° and in energy from 1.05 to 2.93 Mev. Resonances were observed at  $1065 \pm 5$  kev,  $1557 \pm 6$  kev,  $1743 \pm 7$  kev,  $1803 \pm 7$  kev,  $2344 \pm 10$  kev, and  $2468 \pm 10$  kev. (auth)

**4009**

PHASE-SHIFT ANALYSIS OF PROTON SCATTERING BY NITROGEN. A. J. Ferguson (Atomic Energy of Canada, Ltd., Chalk River, Ont.). *Phys. Rev.* **115**, 1660-4(1959) Sept. 15.

A phase-shift analysis was made of a set of angular distributions for the elastic scattering of protons by nitrogen in the energy range 1.0 to 3.0 Mev. Two independent S-wave phase shifts and one P-wave phase shift of hard-sphere type were assumed. Moderately good agreement with the nonresonant scattering below 2.3 Mev and with the scattering at the  $1/2^+$  resonance at 1.557 Mev was obtained, indicating that the gross features of the scattering can be represented in this way. Between 2.3 and 3.0 Mev the fits are poor. The results indicate a broad  $1/2^+$  resonance at 2.32 Mev with a width of 0.55 Mev. (auth)

**4010**

OPTICAL-MODEL ANALYSIS OF EXCITATION FUNCTION DATA AND THEORETICAL REACTION CROSS SECTIONS FOR ALPHA PARTICLES. George Igo (Los Alamos Scientific Lab., N. Mex.; Univ. of Heidelberg, Ger., and Max Planck Inst. for Nuclear Physics, Heidelberg, Ger.). *Phys. Rev.* **115**, 1665-74(1959) Sept. 15.

The complex alpha particle-nuclear potential is determined with small uncertainty at the nuclear surface by experiments with alpha particles in the range of bombarding energies up to 50 Mev in conjunction with this optical-model analysis which assumes that the shape of the complex potential is exponential at the nuclear surface. The calculated reaction cross sections are found to be in satisfactory agreement with excitation function data. The total reaction cross section  $\sigma_R$  for alpha particles in the energy range 0 to 50 Mev on nuclei with charge  $Z = 10, 20, 30, 50, 70$ , and 90 was calculated using the potential  $V_\alpha + iW_\alpha$  obtained from the analysis of elastic scattering data. The calculated values may be interpolated to obtain  $\sigma_R$  for other values of  $Z$ . (auth)

**4011**

ALPHA-DECAY BARRIER PENETRABILITIES WITH AN EXPONENTIAL NUCLEAR POTENTIAL: ODD-MASS NUCLEI. John O. Rasmussen (Univ. of California, Berkeley). *Phys. Rev.* **115**, 1675-9(1959) Sept. 15.

Calculation of barrier penetrabilities, reduced widths, and hindrance factors for odd-mass alpha-particle emitters is made by using the diffuse exponential nuclear potential derived from optical-model analysis of alpha elastic-scattering data. The calculations are made on the same basis as for even-even alpha emitters. (auth)

**4012**

NUCLEAR BAND STRUCTURE IN  $\text{Sc}^{41}$ . R. H. Davis (Florida State Univ., Tallahassee). *Phys. Rev.* **115**, 1679-80(1959) Sept. 15.

Band structure predictions assuming the formation of proton single-particle states above the  $\text{Ca}^{40}$  core in the ground state or one of its excited states are compared with the available data on the elastic and inelastic scattering of protons from  $\text{Ca}^{40}$ . The band expected in  $\text{Sc}^{41}$  above the 3.35-Mev state in  $\text{Ca}^{40}$  is confirmed by experimental results, and some evidence is found for bands above the higher core states. (auth)

**4013**

ENERGY LEVELS IN A BOUNDED ISOTROPIC HARMONIC OSCILLATOR POTENTIAL AND NUCLEAR SHELL STRUCTURE. S. Sengupta and S. Ghosh (Hooghly Mohsin Coll., West Bengal, India). *Phys. Rev.* **115**, 1681-2(1959) Sept. 15.

Energy levels for a three-dimensional bounded harmonic oscillator are obtained for intermediate distances of the

boundary. Energy levels are found to depend on the dimensionless parameter  $\rho_0 = (\omega M/\hbar)R^2$  where  $\rho_0$  is the ratio of the strength of the oscillator levels ( $\hbar\omega$ ) to that of the square well levels ( $\hbar^2/MR^2$ ). Adding a spin-orbit energy 30 times the Thomas value, nuclear energy levels are worked out for the two mass regions at  $A = 50$  and 90. For  $\rho_0 = 6$ , good agreement with the experimental level sequence is obtained. (auth)

**4014**

DECAY SCHEMES OF THE ISOMERS OF  $\text{Tc}^{95}$  AND  $\text{Tc}^{97}$ . John P. Unik and John O. Rasmussen (Univ. of California, Berkeley). *Phys. Rev.* **115**, 1687-92(1959) Sept. 15.

An investigation of the decay schemes of  $\text{Tc}^{95}$  and  $\text{Tc}^{97}$  was made by using high-resolution conversion-electron spectrographs, gamma-ray scintillation detectors, and coincidence techniques. In addition to the 38.9-keV isomeric transition in  $\text{Tc}^{95}$ , eight transitions of the following energies were assigned to  $\text{Mo}^{95}$ : 204.2, 583.9, 763, 767.9, 784, 788.0, 822.5, and 837.3 keV. A decay scheme is proposed. The isomer of  $\text{Tc}^{97}$  was shown to decay by a single M4 transition of  $96.5 \pm 0.1$  keV. The experimental K: L: M relative conversion-electron intensities for this transition are 1:0.48:0.13. (auth)

**4015**

TOTAL NEUTRON CROSS SECTION OF  $\text{Xe}^{135}$  AS A FUNCTION OF ENERGY. E. C. Smith, G. S. Pawlicki, P. E. F. Thurlow, G. W. Parker, W. J. Martin, G. E. Creek, P. M. Lantz, and S. Bernstein (Oak Ridge National Lab., Tenn.). *Phys. Rev.* **115**, 1693-9(1959) Sept. 15.

The total neutron cross section of  $\text{Xe}^{135}$  as a function of energy was remeasured. A sample thickness of  $2.5 \times 10^{18}$  atoms of  $\text{Xe}^{135}$ -gas per  $\text{cm}^2$  was procured from the gases generated in a homogeneous reactor. A mechanical time-of-flight chopper was used to select neutrons in the energy range from 0.01 eV to several thousand eV. The number of  $\text{Xe}^{135}$  atoms in the sample was determined by means of mass spectrometer measurements on the long-lived daughter,  $\text{Cs}^{135}$ . The data of the low-energy resonance were fitted to the single-level Breit-Wigner formula, taking into account Doppler corrections, equally well with the following two sets of parameters: statistical weight factor  $g = 3/2$ ; resonance energy  $\epsilon_0 = 0.08472 \pm 0.00027$  eV; neutron width at energy  $\epsilon_0$ ,  $\Gamma_n^0 = 0.03477 \pm 0.00021$  eV; capture width,  $\Gamma_a = 0.083303 \pm 0.00062$  eV; for  $g = 5/2$ ,  $\epsilon_0 = 0.08415 \pm 0.00028$  eV;  $\Gamma_n^0 = 0.02057 \pm 0.00012$  eV;  $\Gamma_a = 0.09493 \pm 0.00071$  eV. The errors quoted are the standard deviations derived from the statistics of the measurements. Systematic errors are discussed in the body of the paper. No evidence for resonances at energies greater than 0.085 eV was observed. The results described are interpreted in terms of recent considerations on the statistics of the properties of nuclear energy levels. (auth)

**4016**

ELASTIC SCATTERING OF 20.35-Mev PROTONS BY  $\text{Zn}^{64}$ ,  $\text{Zn}^{66}$ , AND  $\text{Zn}^{68}$ . R. W. Boom and J. Reginald Richardson (Univ. of California, Los Angeles). *Phys. Rev.* **115**, 1700-4(1959) Sept. 15.

The absolute differential cross section for the elastic scattering of  $(20.35 \pm 0.25)$ -Mev protons was measured for enriched  $\text{Zn}^{64}$ ,  $\text{Zn}^{66}$ , and  $\text{Zn}^{68}$  foils. In the angular range of 30 to 160° about 50 measurements were made for each foil (spaced from 1 to 5°) to an estimated accuracy of about 5% standard deviation. Scattered protons were detected by nuclear emulsions wrapped around a 4-in. diameter scattering chamber, all angles being exposed simultaneously. Detector energy resolution is 2.5%, angular resolution is 1° standard deviation, and relative angular



shifts are determined to  $0.1^\circ$ . Correction was made for the finite sizes of beam and detector and for multiple scattering in the target and in the detector stopper. The  $\pm 0.25$ -Mev energy spread includes maximum and minimum energies due to beam drift, beam spread, and target foil thickness. Three minima are found for each isotope:  $\text{Zn}^{64}$  at  $63^\circ$ ,  $104^\circ$ , and  $142^\circ$ ;  $\text{Zn}^{66}$  at  $62^\circ$ ,  $102.5^\circ$ , and  $142^\circ$ ; and  $\text{Zn}^{68}$  at  $61^\circ$ ,  $101^\circ$ , and  $142^\circ$ . The absolute cross sections are approximately the same except at the third minima, where for  $\text{Zn}^{64}$ ,  $\text{Zn}^{66}$ , and  $\text{Zn}^{68}$  they are respectively, 1.46, 1.07, and 0.61 mb/sterad. (auth)

#### 4017

ANGULAR DISTRIBUTIONS OF PROTONS FROM THE (d,p) REACTION WITH DEUTERON ENERGIES BELOW THE COULOMB BARRIER. J. P. Schiffer and L. L. Lee, Jr. (Argonne National Lab., Lemont, Ill.). Phys. Rev. **115**, 1705-6(1959) Sept. 15.

Cross sections and angular distributions for the (d,p) reaction to a known  $l = 1$  single-particle state of the captured neutron were measured for seven target nuclides between Ti and Ni. Targets with effective thicknesses of several hundred kev were used with deuteron bombarding energies of 3.8 and 4.5 Mev. The angular distributions were found to be similar, with approximately 2:1 forward peaking and a broad maximum at about  $60^\circ$ . In addition, a sharp but relatively weak peak was observed at about  $25^\circ$  for the lighter of the target nuclides. This is the angle at which the theory of Butler would predict a maximum for neutron capture with  $l_n = 1$ . Analysis of the proton spectra and angular distributions indicates that compound nucleus formation contributes less than 25% to the reaction yield at these deuteron energies. (auth)

#### 4018

CROSS SECTION FOR THE  $\text{Li}^6(n,\alpha)\text{H}^3$  REACTION FOR  $1.2 \leq E_n \leq 8.0$  Mev. R. B. Murray and H. W. Schmitt (Oak Ridge National Lab., Tenn.). Phys. Rev. **115**, 1707-12(1959) Sept. 15.

The cross section for the reaction  $\text{Li}^6(n,\alpha)\text{H}^3$  was measured as a function of neutron energy in the range  $1.2 \leq E_n \leq 8.0$  Mev. An essentially back-to-back method was used, with a thin cylindrical  $\text{Li}^6\text{I(Eu)}$  scintillation crystal placed concentric with and adjacent to a thin-walled ionization chamber containing a deposit of fissile material ( $\text{U}^{238}$  or  $\text{Np}^{237}$ ). The magnitude of  $\sigma_{n\alpha}$  as measured in this experiment depends on the absolute value of  $\sigma_{fiss}(\text{U}^{238})$ , while the shape of the cross section vs energy curve depends on the known energy dependence of  $\sigma_{fiss}(\text{U}^{238}$  or  $\text{Np}^{237})$ . Statistical and other point-to-point uncertainties in the data range from  $\pm 5$  to  $\pm 9\%$ , while the uncertainty in absolute value of the cross section is  $\pm 7\%$ . The cross section obtained from these measurements decreases monotonically from a value of 0.28 barn at  $E_n = 1.2$  Mev to 0.051 barn at  $E_n = 8.0$  Mev. (auth)

#### 4019

NUCLEAR INTERACTIONS AT ENERGIES OVER 1000 Bev. J. C. McEwen (National Research Council, Ottawa, Can.). Phys. Rev. **115**, 1712-19(1959) Sept. 15.

Measurements on two jets, a  $0 + 36p$  jet with primary energy about 2500 Bev and a  $4 + 29\alpha$  jet with primary energy about 8000 Bev/nucleon, are presented. It is shown that the main features of the angular distribution of particles from these two primary jets and a third energetic secondary jet can be explained satisfactorily by the model in which mesons created in a nucleon-nucleon collision are considered to be radiated isotropically from two centers. Further implications of this model are discussed; in particular it is shown that definite restrictions

are imposed on the values of energy and angle of emission of secondary particles; the average transverse momentum is predicted to be relatively constant but to have a lower value not only in the forward and backward directions but also around  $90^\circ$  in the center-of-mass system of the two colliding nucleons. While it is shown that the available experimental data are in accord with these predictions, more events with energies in the region of 1000 Bev must be studied before a definite conclusion can be reached. (auth)

#### 4020

PURE NUCLEAR QUADRUPOLE RESONANCES IN PARAMAGNETIC IRON-GROUP HALIDES. R. G. Barnes and S. L. Segel (Iowa State Univ., Ames). Phys. Rev. Letters **3**, 462-4(1959) Nov. 15.

Nuclear quadrupole resonances were detected in  $\text{TiCl}_3$ ,  $\text{TiCl}_4$ ,  $\text{VCl}_3$ ,  $\text{CrCl}_3$ ,  $\text{CrBr}_3$ , and  $\text{CrCl}_2$ . The observed  $\text{Cl}^{37}$  and  $\text{Br}^{81}$  resonance frequencies are listed and an estimate of the covalent character  $\alpha^2$  of the metal-halogen bond in these compounds is given. (C.J.G.)

#### 4021

DIPOLE STATE IN NUCLEI. G. E. Brown and M. Bolsterli (Univ. of Minnesota, Minneapolis). Phys. Rev. Letters **3**, 472-6(1959) Nov. 15.

It is shown that the energies of the positions of single-particle excitations lying between zero bombarding energy and the binding energy of the last neutron cannot be compared directly due to dipole absorption. Because many particle-hole states can be formed, with the states almost degenerate in energy, the particle-hole interaction can have a profound effect in redistributing dipole transition strength. These effects are demonstrated by a schematic model which shows how coherent effects are able to push the dipole transitions to high energies. Protons in a potential well are considered, and the discussion is extended to protons and neutrons in a nucleus. The discussion is limited to nuclei with double closed shells, neglecting the influence of the few valence nucleons, spin, and considering only transitions from  $l$  to  $l + 1$ . (C.J.G.)

#### 4022

INTERPRETATION OF ISOTOPE SHIFTS IN THE RARE GASES. A. P. Stone (Union Christian Coll., Alwaye, South India). Proc. Phys. Soc. (London) **74**, 424-31(1959) Oct. 1.

A successful qualitative interpretation of observed isotope shifts in Ne, Ar, Kr, and Xe is obtained by considering the specific mass effect in intermediate coupling. (auth)

#### 4023

THE DECAY OF  $^{144}\text{Ce}$ . N. J. Freeman (Bedford Coll., London). Proc. Phys. Soc. (London) **74**, 449-56(1959) Oct. 1.

The beta, gamma, and internal conversion electron spectra of  $\text{Ce}^{144}$  were studied with a magnetic spectrometer, scintillation counter, and coincidence techniques. The internal conversion coefficients of the 80 and 133 kev  $\gamma$  rays were measured. Four partial beta spectra were observed and new evidence was found for a level at 166 kev in the  $\text{Pr}^{144}$  nucleus. No evidence was found for the 95 and 145 kev  $\gamma$  rays in the decay. (auth)

#### 4024

THE DECAY OF  $^{147}\text{Pm}$ . R. Jakeways and W. G. V. Rosser (The University, Exeter, Eng.). Proc. Phys. Soc. (London) **74**, 478-9(1959) Oct. 1.

The 121 kev  $\gamma$  ray in the decay of  $\text{Pm}^{147}$  was found to be in coincidence with  $\beta$  rays of maximum energy  $\sim 2$  Mev and therefore cannot arise during the  $\beta$  decay of  $\text{Pm}^{147}$  to  $\text{Sm}^{147}$  (C.J.G.)

#### 4025

THE RELATIVE STOPPING POWERS OF PURE GASES TO

THAT OF AIR. Norman A. Bally and George C. Brown (Roswell Park Memorial Inst., Buffalo). Radiation Research 11, 745-53(1959) Dec.

A comparison between theoretical and experimental values of the relative stopping powers of pure gases for electrons has been presented. The experimental data were obtained by using the  $\beta$ -ray spectrum from thick sources of  $S^{35}$ ,  $P^{32}$ , and  $Y^{90}$ . The gases studied were: hydrogen, helium, nitrogen, oxygen, air, neon, argon, krypton, and xenon. Values of the relative stopping powers for bone and muscle have been computed from the experimental data. (auth)

## Particle Accelerators

4026 MURA-514

Midwestern Universities Research Assn., Madison. EFFECTS OF RADIAL STRAIGHT SECTIONS ON THE BETATRON OSCILLATION FREQUENCIES IN A SPIRAL SECTOR FFAG ACCELERATOR. R. A. Dory and P. L. Morton. Sept. 4, 1959. 10p. OTS.

Results obtained from the IBM-704 digital computer on the introduction of radial straight sections into spiral sector FFAG accelerators are given. The effect of radial straight sections on the magnetic field in the median plane is studied first. Then the variation of the betatron oscillation frequencies with energy is determined for various lengths of radial straight sections and for various combinations of the number of straight sections and spirals. These results bear out the theorem in MURA report 434, which describes a method of introducing the radial straight sections in such a way as to keep the betatron oscillation frequencies independent of energy. (auth)

4027

STRAY RADIATION DOSIMETRY AROUND PULSED ACCELERATORS. J. S. Handloser (Brookhaven National Lab., Upton, N. Y.). Health Phys. 2, 165-71(1959) Oct.

The dosimetry of stray radiation fields around pulsed accelerators is complicated by the fact that the radiation comes in pulses and by the mixed nature of the radiation usually produced by these accelerators. Suitable instrumentation for pulsed radiation consists of special uses of standard ratemeters and counters and integrating type ion chamber instruments. Fixed monitors and personnel monitoring schemes must be adapted to this special use. If a mixture of radiation is to be measured with ionization chambers, the physical dose can be obtained if the chamber is tissue equivalent, but an effective or weighted average value of RBE must be determined to obtain the biological dose. An experimental procedure using a cloud chamber was developed to measure the distribution of linear energy transfer (l.e.t.). Stereoscopic photographs of the tracks in the cloud chamber are taken. The length of every track is measured and the optical density classified. By calibration with tracks of known particles, the energy deposited in the sensitive volume from different l.e.t. classes can be calculated. An effective RBE is obtained from values of RBE as a function of l.e.t. (auth)

## Plasma Physics and Thermonuclear Processes

4028 AD-65795

Johns Hopkins Univ., Baltimore. Inst. for Cooperative Research. FUNDAMENTAL CHARACTERISTICS OF HIGH CURRENT

ARCS. Final Report. T. Benjamin Jones. June 1955. 39p. Contract Nonr-248(09).

The principal results of a study of some of the fundamental characteristics of high-current arcs are outlined. The arcs studied were in the current range of 10 to 200 amp direct current with virtually all tests made at atmospheric pressure. The majority of the arcs were drawn between horizontal rod electrodes in a sealed chamber where close control of the enclosing gas and other variables could be maintained. It was found that the electrical data could be repeated to a precision far better than most previously published studies of arcs, many of which were made under practical operating conditions such as welding, circuit switching, etc. Much of the work was done in atmospheres of pure argon, helium, and neon and in various mixture combinations of these three gases. This eliminated chemical reactions and contributed further to the uniformity of data. Seven distinct investigations were made. The first of these involved a new technique of studying arcs between a rod and a flat surface moved with respect to each other at high relative speeds. The anode spot formations could be accurately observed, and much information on current densities, melting efficiencies, etc., was obtained. Four of the investigations involved arcs in the inert gases and mixtures thereof with various types of electrode materials. With electrodes of tungsten, molybdenum, tantalum, titanium, iron, and copper it was possible to develop a semi-empirical equation which accurately expressed the electrical characteristics of such arcs. The remaining two investigations were concerned with oscillations of current, voltage, light, and sound produced within a dc arc and the effect of the moisture content of air on the behavior of high-current arcs. Two distinct types of oscillations were discovered, the frequency in one case being as high as 60 megacycles. Arcs in air with moisture contents up to 100%, e.g., live steam, were studied. In all cases the presence of moisture caused a rise in arc voltage for a given current. The work is summarized with sufficient data, curves, and photographs to support the principal conclusions. (auth)

4029 AERE-L-103

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

LECTURES ON THE HYDROMAGNETIC STABILITY OF A CYLINDRICAL PLASMA. II. INVESTIGATIONS OF STABILITY USING INTEGRAL PROPERTIES OF THE HYDROMAGNETIC EQUATIONS. R. J. Tayler. Sept. 1959. 32p. BIS.

In some stability problems it is either impossible or inconvenient to solve the normal mode equations completely. Then it is sometimes possible to obtain more limited information about the stability of the system by studying integral properties of the hydromagnetic equations. One such method can be used if the system is in static equilibrium and possesses a constant energy; then the stability against any perturbation can be investigated by finding whether or not the perturbation increases the potential energy of the system. A brief account of the hydromagnetic energy principle is given and from it are deduced some general stability properties of a cylindrical plasma. It is also shown that, in problems to which the energy principle cannot be applied, stability criteria can sometimes be obtained by studying volume integrals of the solutions of the normal mode equations. In such cases the reality or sign of the disturbance growth rate can be found without the normal mode equations being solved. (auth)



**4030 AERE-L-105**

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

LECTURES ON THE HYDROMAGNETIC STABILITY OF A CYLINDRICAL PLASMA. IV. SUYDAM'S NECESSARY CONDITION FOR STABILITY. R. J. Tayler. Sept. 1959. 30p. BIS.

It has been shown that the stabilized pinch may suffer from very localized surface instabilities. This has been demonstrated by constructing unstable perturbations but it has not been shown that these are the worst possible perturbations. Suydam has generalized these results in two ways by trying to find the worst possible perturbation and by considering arbitrary configurations of a cylindrical plasma instead of only those of the stabilized pinch type. He has solved the third Euler-Lagrange equation of the energy principle and obtained a criterion for the resulting perturbation to be stable. The solution of the Euler-Lagrange equation may in principle lead to either a minimum or a maximum and he has not been able to show that it always leads to a minimum. Thus there may still be worse perturbations and the stability criterion is necessary but it may not be sufficient for stability. Several examples are given of fields which satisfy Suydam's criterion. (auth)

**4031 AERE-R-2957**

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

WALL MATERIALS FOR THERMONUCLEAR DEVICES. LIMITATIONS DUE TO EVAPORATION. R. Hancox. Aug. 1959. 31p. BIS.

Evaporation of material from the walls of a vessel containing a high-temperature plasma and the limitations which it imposes on the thermal loading of the wall are considered. Limiting temperatures are derived for walls of both metals and refractory oxides. Under steady state conditions it is shown that for metals thermal loadings of the wall of the order 100 watts/cm<sup>2</sup> are feasible, but that for the oxides thermal loadings must be at least an order of magnitude less than this. Under transient conditions the difference between metals and refractory oxides is found to be less important. (auth)

**4032 AFBMD-TN-59-5**

Avco Corp. Avco-Everett Research Lab., Everett, Mass. END EFFECTS IN MAGNETOHYDRODYNAMIC CHANNEL FLOW. Research Note 135. Frank Fishman. June 1959. 16p. Contract AF04(647)-278.

Some effects associated with the termination of electrodes and magnetic field in an otherwise uniform magnetohydrodynamic channel flow are investigated theoretically. The assumption is made that the magnetic Reynolds number based on the channel height and the interaction parameter (the product of the magnetic Reynolds number with the ratio of magnetic to gas dynamic pressure) are both small, so that the induced magnetic field is negligible and the gas velocity and conductivity are uniform everywhere. Significant exchange of energy may obtain under these conditions in long channels. Because of the end effects, the electrodes may carry more, or less, current than the same length of electrode in the middle of a long channel; this leads to the definition of a length representing the end correction for current. Similarly a difference in the total force on the working fluid leads to a length representing the end correction for force. These lengths are calculated for various geometries. The electrical efficiency of a channel acting

as a generator is computed for these same conditions. It is shown that the end effects decrease generator efficiency least if the magnetic field extends at least one-half a channel height beyond the end of the electrodes (for generators of high nominal efficiency). Under these conditions, and if the electrodes are not less than 1% of the channel height long, they have an effective length for current about 0.4 channel heights greater than their actual length. (auth)

**4033 AFBMD-TN-59-6**

Avco Corp. Avco-Everett Research Lab., Everett, Mass. AN ARC TUNNEL FOR MAGNETOHYDRODYNAMIC STUDIES. Research Note 132. Richard Rosa. June 1959. 13p. Contract AF04(647)-278.

An arc wind tunnel or plasma jet can be used to produce a steady gas flow over a considerable range of temperature, pressure, and gas composition. In particular, it can produce gas temperatures sufficient for appreciable thermal ionization to occur, especially if the gas is seeded with a small amount (1% or less) of alkali metal vapor. For this reason it should be a useful tool for magnetohydrodynamic (MHD) studies. A tunnel developed for studies related to MHD acceleration of and power generation from a conducting gas stream is discussed. Design criteria for such a facility are discussed, and the arc tunnel experience to date is described. A magnet for use with this tunnel was also built and results of efforts to generate electric power from the interaction of the hot gas stream and the magnetic field are described. (auth)

**4034 AFCRC-TN-58-581**

Illinois. Univ., Urbana. Electric Engineering Research Lab.

THERMODYNAMICS OF A FULLY IONIZED GAS IN A STRONG MAGNETIC FIELD. Scientific Report No. 5. Rudolph C. Hwa. Sept. 25, 1958. 17p. Project No. 4156. Contract AF19(604)-2152. (AD-206579).

Thermodynamic properties of a fully ionized gas in a strong magnetic field are investigated. An entropy balance equation is derived from the statistical point of view. If heating by shock wave and cooling by Bremsstrahlung radiation are neglected, the plasma behaves quasi-statically in a strong magnetic field. The thermodynamic process that it undergoes is adiabatic and reversible. The mechanism that keeps the plasma quasi-static is the rapid gyromotion of the particles around the magnetic field lines, while the thermodynamic reversibility is due to the absence of randomization processes. (auth)

**4035 AFOSR-TN-59-925**

Plasmadyne Corp., Santa Ana, Calif. AN EXPERIMENTAL STUDY OF SPARK STABILIZATION BY A GAS VORTEX. Christopher Cobb and Vernon H. Blackman. Aug. 28, 1959. 32p. Project No. 4750. Contract AF49(638)-334.

Pressure gradients in a gas flow have been used for several years to stabilize an electric discharge. This work is concerned mainly with a vortex flow in which the low-density channel along the axis of the vortex can be used to confine an electric arc. The interaction between an electric discharge and a gas flow was investigated. The work was oriented toward the discharge of sparks along the axis of a vortex, with the feeling that a time resolved photographic study of spark stabilization and growth in a vortex channel could shed information on the stabilization of arcs by the vortex motion. (W.L.H.)

**4036 MATT-Q-8**

Princeton Univ., N. J. Project Matterhorn. QUARTERLY REPORT COVERING THE PERIOD JULY 1-

SEPTEMBER 30, 1959. 32p. Contract AT(30-1)-1233. OTS.

Measurements on Etude and B-3 indicate that rapid discharges, from 1 to 30 times per second, effectively clean the vacuum chamber, and may be a satisfactory substitute for baking. Continuing measurements with B-1 show that for currents above the Kruskal limit, the discharge channel is displaced from the tube axis, and rotates uniformly about this axis with a frequency of about 200 kc. Below the Kruskal limit oscillations are observed at about the currents predicted for the higher modes of kink instability, and transverse light scans show that the distortion of the current channel for each mode also agrees with the theory. While fabrication of most of the standard components for Model C is proceeding satisfactorily, substantial delays and cost increases occurred on certain major components. Design of the Stage II components, including the divertor and the magnetic pumping equipment, is approaching completion. Analyses of electrostatic instabilities successfully isolated the conditions under which positive ion waves may be excited. These conditions are satisfied in the stellarator during ohmic heating, and the resultant finite-amplitude disturbance may produce the diffusion observed across the lines of force. (For preceding period see MATT-Q-7.) (auth)

**4037** ORNL-2838

Oak Ridge National Lab., Tenn.

SOME EXACT RADIATION SOLUTIONS TO VLASOV'S EQUATIONS. L. C. Biedenharn. Dec. 11, 1959. 23p. Contract W-7405-eng-26. OTS.

A class of exact solutions to the Vlasov equations which shows electromagnetic radiation is constructed, and a typical example discussed in some detail. Since velocities larger than  $c$  appear to be possibly of importance in these solutions, an exact radiating solution to the relativistic Vlasov equations is constructed, which, though much more specialized than the nonrelativistic solutions, shows that unphysically large velocities in the nonrelativistic solutions are not essential for the radiation there obtained. (auth)

**4038** SCTM-110-56(51)

Sandia Corp., Albuquerque, N. Mex.

CRITERION FOR HYDROMAGNETIC SHOCK FRONTS. O. G. Owens. May 28, 1956. 9p. OTS.

Assuming infinite electrical conductivity, but with no restrictions on the mean free electric charge density and Maxwell's displacement current, an analytical criterion is derived which determines the characteristic surfaces (shock-fronts) associated with any flow satisfying the equations of hydromagnetics. (auth)

**4039** TID-7582

Oak Ridge National Lab., Tenn.

PROCEEDINGS OF A CONFERENCE ON THE THEORETICAL ASPECTS OF CONTROLLED FUSION RESEARCH, GATLINBURG, TENNESSEE, APRIL 27-28, 1959. Nov. 1959. 232p. (ORNL-2805). OTS.

A compilation of papers given at the Gatlinburg conference on theoretical aspects of controlled fusion research is presented. Unlike the previous meeting at Gatlinburg, which covered all aspects of Sherwood, this meeting was limited to theoretical papers. (W.D.M.)

**4040** TID-7582(Paper 1)

New York Univ., New York. Inst. of Mathematical Sciences.

THERMALIZATION OF A FAST ION IN A PLASMA. Herbert C. Kranzer. 7p.

A fast ion is injected into a plasma in equilibrium. The

time history of the probability distribution of this ion in velocity space is determined. This is done by numerical integration of the linearized, space-independent Fokker-Planck equation with both the ion-ion and ion-electron terms retained. The mean time of thermalization is calculated for several widely separated injection velocities. (auth)

**4041** TID-7582(Paper 2)

Princeton Univ., N. J. Project Matterhorn and Los Alamos Scientific Lab., N. Mex.

A VARIATIONAL CALCULATION OF PLASMA TRANSPORT PROPERTIES. Ira B. Bernstein and Bruce Robinson. 7p.

A variational principle is given for the electrical conductivity of a fully ionized plasma. Use of a very simple trial function yields Spitzer's value to within 2%. The method can be generalized so as to apply to all transport coefficients. (auth)

**4042** TID-7582(Paper 6)

Gt. Brit. Atomic Weapons Research Establishment, Aldermaston, Berks, England.

RADIAL OSCILLATIONS OF CYLINDRICAL PLASMA CONFINED BY AXIAL MAGNETIC FIELDS. J. B. Taylor. 4p.

Radial oscillations of a cylindrical plasma, confined by an axial magnetic field have recently been observed. These oscillations are discussed on the basis of the magnetohydrodynamic equations. The effect of the proximity of a conducting wall and of differing mass distributions within the plasma are considered. It is found that the frequency is insensitive to these factors and depends only on the mass of plasma and the confining magnetic field. These oscillations should therefore provide a useful measure of the mass of gas swept up in a fast pinch device. (auth)

**4043** TID-7582(Paper 7)

Los Alamos Scientific Lab., N. Mex.

HYDROMAGNETIC ENERGY TRANSPORT IN ION. W. B. Riesenfeld. 2p.

The transport of energy by hydromagnetic waves is calculated, with view toward application to the heating process of the Los Alamos rotating plasma mirror device. (auth)

**4044** TID-7582(Paper 8)

Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.

WAVES IN A PLASMA. W. P. Allis. 16p.

Many papers that consider the effects of terminal motions, finite Larmor radius, collisions, and so forth on the propagation of plane waves through a plasma in the presence of a magnetic field have recently appeared. The necessary mathematics obscures the origin of many of the predicted phenomena, and as these also depend critically on the range of frequency, plasma density, and the magnetic field that is considered, it has seemed worth while to view the complete range of these last three variables in the simple limit in which there are: (a) no density gradients; (b) no collisions; and (c) no thermal motions. The thermal motions affect mainly the slow waves whose phase velocity is comparable to the thermal motions. For this reason, among others, it is particularly interesting to note the conditions under which slow waves exist. (auth)

**4045** TID-7582(Paper 9)

Princeton Univ., N. J. Project Matterhorn.

OSCILLATIONS OF A FINITE COLD PLASMA IN A STRONG MAGNETIC FIELD. Carl Oberman and John Dawson. 7p.

Most treatments of plasma oscillations have been given



for plasmas of infinite extent. Such treatments give information on the propagation of electromagnetic waves inside a plasma, but give no indication of the coupling between these waves and the electromagnetic fields outside the plasma. This coupling determines the radiation from, say plasma oscillations, as well as the response of the plasma to externally applied fields, where the fields may be either wave fields or near fields produced by currents and charges near the plasma surface. Since the electromagnetic field affords one of the most fruitful means for investigating the behavior of plasmas, it is important to know the size and effects of this coupling. (auth)

**4046** TID-7582(Paper 12)

Oak Ridge National Lab., Tenn.

**CRITICAL CURRENT FOR BURNOUT IN AN OGRA-TYPE DEVICE.** Albert Simon. 5p.

A complete algebraic analysis has been obtained for the variation of the steady state ion density  $n_+$  with injected current  $I$  in an OGRA-type fusion device (i.e., a device based on trapping of ions by breakup of energetic molecular ions on collision with either the background gas or trapped ions). The most general variation of  $n_+$  with  $I$  is shown to be an s-curve with at most three roots of  $n_+$  for a given input  $I$ . A physical interpretation of these three roots is given. In addition algebraic expressions are obtained for the two currents at which the bends in the s-curve occur. It will be necessary to attain the larger current in order to build up a high density plasma when the density is being increased from below. On the other hand, once the high density has been achieved it may be maintained by steady injection of a current larger than the lower value. (auth)

**4047** TID-7582(Paper 13)

Gt. Brit. Atomic Weapons Research Establishment, Aldermaston, Berks, England.

**ABSOLUTE CONTAINMENT OF CHARGED PARTICLES IN A MAGNETIC FIELD.** J. B. Taylor. 4p.

In a magnetic field of the "mirror" type certain particles are "absolutely" contained irrespective of the constancy or otherwise of the magnetic moment. A criterion for absolute containment is derived and shown to resemble that for containment on the adiabatic approximation. (auth)

**4048** TID-7582(Paper 14)

Stevens Inst. of Tech., Hoboken, N. J. and Israel Inst. of Tech., Haifa.

**ON PINCH STABILIZATION OVER LONG DURATION.**

George Schmidt and I. Shechtman. 5p.

Long wave length perturbation modes of a linear pinch can be effectively stabilized through the use of a concentric conducting cylinder. In practice the finite conductivity of the cylinder prevents stabilization of slow perturbations. For the stabilization of these modes permanent diamagnets are required. Some methods are proposed for simulating such diamagnets with the help of liquid metallic walls in fast motion. Arrangements are shown for isolating static magnetic fields where the moving liquid metals perform the function of a diamagnet with  $\mu = 0$ . (auth)

**4049** TID-7582(Paper 15)

California. Univ., Livermore. Lawrence Radiation Lab. **BOUNDARY LAYER FORMATION IN THE PINCH.** S. A. Colgate, G. Gibson, and J. Killeen. 24p.

Containment of plasmas may be achieved by either vacuum magnetic fields or pinch magnetic fields. Vacuum magnetic fields are created by external coils, whereas in the pinch device the primary current is induced in the plasma, and without this current there exists no containing

field. The current and magnetic field spatial distributions are of interest since the degree of stability of the pinch plasma column is dependent on the sharpness of the boundary. Processes that determine the pinch current's spatial distribution for times prior to the implosion of a deuterium plasma are examined. A one dimensional problem is treated where there is an externally applied stabilizing magnetic field in the direction of the electric field which immobilizes the charged particles in the plasma. It is assumed that this field is of such a magnitude as to make the heat and charged particle diffusion terms across the field negligible. In this manner, wall effects are also conveniently eliminated. Further, the strength of the self or pinching magnetic field (component of the magnetic field normal to the electric field) is considered to be small relative to the stabilizing magnetic field over the interval of time for which the results are significant. Hence, mass motion of the plasma is ignored. As a result of these assumptions, the stabilizing field does not appear explicitly in the calculation. The validity of these assumptions is examined in the discussion of the results. (auth)

**4050** TID-7582(Paper 16)

California. Univ., Berkeley. Lawrence Radiation Lab. **CIRCUIT DYNAMICS OF THE PINCH.** J. Killeen and B. A. Lippmann. 10p.

Instead of analyzing in detail a portion of a hydromagnetic pinch apparatus and replacing the remainder by a boundary condition, the entire pinch apparatus is treated as a single dynamical system. A circuit equation and a mechanical equation, coupled together, result. These equations describe the dynamical development of the pinch and exhibit explicitly its dependence on the physical parameters (electrical and mechanical) of the system. As examples, the equations are used to analyze the snow-plow model and the adiabatic pinch, yielding curves that show the geometrical development of the pinch in time, as well as the distribution of mechanical and magnetic energies at any stage. Analogous analyses may be made for other physical quantities of interest, and can be used to adjust the parameters of the system so as to optimize specific pinch characteristics. (auth)

**4051** TID-7582(Paper 17)

California. Univ., Livermore. Lawrence Radiation Lab.

**PROGRESS IN THE ANALYSIS OF THE ASTRON E-LAYER.** Lewi Tonks. 2p.

The E-layer of the Astron, even in its uniform portion far from the ends, is complicated by the slowing down of the electrons, by their scattering in angle, by the diamagnetism of the reacting plasma, and by possible rotation effects from the angular momentum imported by the repeated influx of the high energy E-layer electrons. These problems are discussed and initial steps in their solution are outlined. (W.D.M.)

**4052** TID-7582(Paper 18)

Space Technology Labs., Inc., Los Angeles; California Inst. of Tech., Pasadena; and Illinois. Univ., Urbana. **LONGITUDINAL PLASMA OSCILLATIONS IN AN ELECTRIC FIELD.** B. D. Fried, M. Gell-mann, J. D. Jackson, and H. W. Wyld. 18p.

The properties of longitudinal plasma oscillations in an external electric field are investigated. In a completely linear approximation, it is found that the d-c electric field introduces essentially no new effects. A quasi-linear approximation is also considered, in which couplings between different plasma modes are neglected while the space-averaged distribution functions are assumed to be approxi-

mately independent of time. In this case, a Maxwellian distribution function is found to be always unstable against the growth of very long wavelength oscillations. (auth)

**4053** TID-7582(Paper 19)

Oak Ridge National Lab., Tenn.

INSTABILITIES DUE TO ANISOTROPIC VELOCITY DISTRIBUTIONS. E. G. Harris. 7p.

If the velocity distributions of the electrons and ions of a plasma are sufficiently anisotropic there exist both longitudinal and transverse unstable waves. These instabilities are investigated using the Vlasov equations. Most of the work was done on the longitudinal waves and with the assumption that the coupling between longitudinal and transverse modes could be neglected. Since most of the proposed thermonuclear machines create plasmas with anisotropic velocity distributions these instabilities may have serious consequences. (auth)

**4054** TID-7582(Paper 20)

Princeton Univ., N. J. Project Matterhorn.

THE BREAKING OF FINITE AMPLITUDE PLASMA OSCILLATIONS. John Dawson. 9p.

Large amplitude, plane, electrostatic oscillations of a cold plasma were followed numerically. The amplitude was taken to be just slightly larger than that at which the waves begin to break. It was found that the order wave motion was largely converted to individual particle motions during the first few oscillations. About 50% of the wave energy was lost in two oscillations. A few particles were found to be accelerated to very high energies (of the order of ten times the average energy). (auth)

**4055** TID-7582(Paper 22)

Princeton Univ., N. J. Project Matterhorn.

STABILITY OF HELICALLY INVARIANT FIELDS ON THE PARTICLE PICTURE. Russell Kulsrud. 3p.

The stability of a system with helically invariant fields is recalculated using the energy principle based on particle motions developed by Kruskal and Oberman, and also by Rosenbluth and Rostoker. It is found that in the case of isotropic pressure there is no change from the results previously calculated from the hydromagnetic fluid equations. In the case of anisotropic pressure the results are roughly the same unless  $p_{\perp}$  is much greater than  $p_{\parallel}$ . In this limit the "mirror-type" instability of Newcomb is found. (auth)

**4056** TID-7582(Paper 23)

Princeton Univ., N. J. Project Matterhorn.

A VARIATIONAL PRINCIPLE FOR EQUILIBRIA FROM THE PARTICLE POINT OF VIEW. Russell Kulsrud. 3p.

The equilibrium equations for a plasma from the particle point of view are written down in the small  $m/e$  limit according to Chew, Goldberger, and Low. These are discussed in the case of a toroidal geometry with magnetic surfaces. The Boltzman function  $f$  depends only on the energy, the magnetic moment, and the magnetic surface. A variational principle equivalent to the full system of self-consistent equations is derived under this constraint in  $f$ . It is found to be necessary to introduce one more constraint on the particles (besides the constants of the motion for the particle, the magnetic moment, and the magnetic surface). This is a generalization of the longitudinal invariant. (auth)

**4057** TID-7582(Paper 24)

New York Univ., New York. Atomic Energy Commission Computing and Applied Mathematics Center.

ON THE STABILITY OF A HOMOGENEOUS PLASMA WITH NON-ISOTROPIC PRESSURE. R. Lüst. 4p.

The stability of a homogeneous plasma in a homogeneous

magnetic field with non-isotropic pressure is investigated by applying the macroscopic plasma equations. It is found that the plasma is unstable if the pressure along the magnetic lines of force is too large compared to the pressure perpendicular to the magnetic field; it is also unstable if the perpendicular pressure is too large compared to the parallel pressure. (auth)

**4058** TID-7582(Paper 25)

California. Univ., Livermore. Lawrence Radiation Lab.

PRESSURE BALANCE AND STABILITY CRITERIA IN THE MIRROR MACHINE. R. F. Post. 9p. (UCRL-5524).

For some special cases where the plasma energy density is relatively small compared to the magnetic energy density, solutions to the tensor magnetostatic pressure-balance equations are constructed for the mirror machine. These solutions can be made approximately to conform to previously derived diffusion equilibrium solutions. The solutions thus obtained can be subjected to various existing stability criteria, in order to derive critical relative plasma pressure values. These critical  $\beta$  values are generally of order 0.25, and thus are probably high enough to lie outside of the range of validity of the low  $\beta$  solutions for which they were calculated. (auth)

**4059** TID-7582(Paper 26)

Princeton Univ., N. J. Project Matterhorn.

SOME HYDROMAGNETIC EQUILIBRIA. John L. Johnson and John M. Greene. 9p.

Hydromagnetic equilibria are obtained for a variety of situations which differ little from that of a zero pressure uniform axial magnetic field. The perturbations considered are particle pressure, axial current, curvature of the system, and multipolar fields. These equilibria differ from those which were obtained previously in the thermonuclear program in that the lowest order term in an asymptotic expansion of the magnetic surface is not cylindrically symmetric but is a function of both  $r$  and  $\theta$ . The problem is reduced to the solution of a second order nonlinear partial differential equation. If it is assumed that the lowest order terms in the expressions for the material pressure and axial current distributions are of the form  $a + b \Psi_0$  where  $a$  and  $b$  are constants and  $\Psi_0$  is the zeroth order magnetic surface, the equation is linear and can be integrated directly. (auth)

**4060** TID-7582(Paper 27)

New York Univ., New York. Inst. of Mathematical Sciences.

SOME AXIALLY SYMMETRIC PROBLEMS IN MAGNETO-HYDRODYNAMICS. Martin Schechter. 11p.

The details are carried out for solving certain boundary value problems for  $\nabla p = J \times B$  considered by Grad and Rubin. It is shown how the given data allow a reduction to the Dirichlet problem for a non-linear elliptic equation. The method of iterations is used to solve the problem in small domains. (auth)

**4061** TID-7582(Paper 29)

New York Univ., New York. Inst. of Mathematical Sciences.

ADIABATIC INVARIANTS OF CHARGED-PARTICLE MOTION. Clifford Gardner. 9p.

The problem of the motion of a charged particle of small mass is considered from the standpoint of perturbation theory. By a canonical transformation expressed as a power series in the mass, the Hamiltonian of the system is transformed so that Kruskal's series for the magnetic moment appears as the momentum conjugate to an ignorable coordinate. This furnishes a new proof of Kruskal's theorem on the constancy of the magnetic moment and



also produces a Hamiltonian for the guiding-center motion, with two degrees of freedom. If now the particle is trapped between two magnetic mirrors in a field which varies slowly with time, a repetition of the perturbation treatment using the guiding-center Hamiltonian gives a power series which is a generalized second or longitudinal adiabatic invariant. The series is constant to all orders in the mass. Also, the dynamical system is reduced to one having one degree of freedom. (auth)

**4062** TID-7582(Paper 30)

Princeton Univ., N. J. Project Matterhorn.  
AN "ADIABATIC INVARIANCE THEOREM" FOR LINEAR OSCILLATORY SYSTEMS OF FINITE NUMBER DEGREES OF FREEDOM. Andrew Lenard. 6p.

The asymptotic behavior of a linear, oscillatory system in the limit where the coefficients vary slowly compared with the characteristic frequencies is considered. Two theorems are stated and proven rigorously. The first one concerns the asymptotic expansion at times when the coefficients do not vary. The second states the sense in which the expansion is an approximation to the exact solution. Two simple special cases, given as examples, are (1) the quantum mechanical adiabatic theorem, and (2) the adiabatic invariance theorem for the harmonic oscillator. (auth)

**4063** TID-7582(Paper 31)

General Electric Co. Research Lab., Schenectady, N. Y.  
PARTICLE ORBITS IN TIME DEPENDENT AXISYMMETRIC MAGNETIC FIELDS. S. Tamor. 4p.

The motion of a charged particle in a rapidly varying spatially uniform axisymmetric magnetic field is studied. For particular time dependences of the cyclotron frequency,  $\omega(t)$ , the trajectory is obtainable in closed form. If the field is varying slowly at the initial and final times a simple connection is found between the initial and final orbits. If two field programs are considered,  $\omega(t)$  and  $\omega_f(t)$  each of which varies rapidly, but whose ratio changes slowly, it is found that this connection is the same for both time dependences and hence defines an extended adiabatic invariant. (auth)

**4064** TID-7582(Paper 32)

New York Univ., New York. Inst. of Mathematical Sciences.

MAGNETO-HYDRODYNAMIC SHOCK STRUCTURE WITHOUT COLLISIONS. Cathleen S. Morawetz and Herbert Goertzel. 6p.

The problem of proving the existence of a magnetohydrodynamic shock without collisions consists of finding a solution to two Boltzmann equations without collision terms and two Maxwell equations. For a classical shock structure the solution would lead from one constant state at large distances in one direction (the state ahead) to a different constant state at large distances in the other direction (the state behind). However, a solution which leads from a constant state ahead to a periodic state behind may be interpreted as part of a shock if the entropy in some sense increases. Such solutions have been shown to exist theoretically if the mass ratio is very small and the characteristic wavelength if kept fixed. This length is the geometric mean of the distances the ions and electrons move forward in a complete change of phase in a constant magnetic field. The prescribed distribution function for the ions ahead of the shock is a Maxwellian cut-off at some speed. Such solutions are computed for various values of the Alfvén number, pressure and cut-off speed ahead of the shock. For certain cut-off speeds there is no "shock." For other values of the cut-off speed, in a certain range

of Mach numbers, there is a shock in the sense described above with a large change in the mean magnetic field. The mean magnetic field, for example, may be increased through the shock by 75% and the oscillation is about 20% of the final value. Therefore entropy increase is a large fraction of the theoretical maximum. (auth)

**4065** TID-7582(Paper 33)

New York Univ., New York. Inst. of Mathematical Sciences.

INCREASED DISPERSION AND RESISTIVITY IN A NON-STEADY PLASMA. Harold Grad. 3p.

In thermodynamic equilibrium, charge fluctuations in a plasma give rise to electric field fluctuations, i.e., they excite plasma oscillations. In a non-equilibrium state, there are external sources of excitation. These give rise to additional plasma oscillations superposed on the thermal background. These phenomena are discussed briefly. (W.D.M.)

**4066** TID-7582(Paper 34)

Argonne National Lab., Lemont, Ill.

STABILITY OF RADIOFREQUENCY PLASMA CONFINEMENT. J. W. Butler. 4p.

The stability of confinement of a conducting fluid by r-f electromagnetic fields is investigated statically in plane geometry by assuming that only time averaged field pressures need be considered. It is found that the set of perturbation wave numbers can be divided into stable and unstable intervals. In general, the confinement is stable if the wave length of the boundary deformations is sufficiently short. Similar results are obtained if various steady magnetic fields are also postulated to be present. (auth)

**4067** UCRL-5447

California. Univ., Livermore. Lawrence Radiation Lab.  
HYDROMAGNETIC STABILITY OF A DIFFUSE LINEAR PINCH. William A. Newcomb. Aug. 1959. 57p. Contract W-7405-eng-48. OTS.

The hydromagnetic energy principle is applied to the derivation of necessary and sufficient conditions for the hydromagnetic stability of a linear pinch with distributed plasma current (a diffuse linear pinch). The results are quite general in that the axial and azimuthal components of the magnetic field, which determine the structure of the pinch completely, are treated as arbitrary functions of distance from the axis. For purposes of illustration, the general results are applied to the limiting case of a pinch with the plasma current confined to an infinitely thin layer (a sharp pinch). (auth)

**4068**

THE EQUATIONS OF MAGNETOHYDRODYNAMIC ADIABATIC EQUILIBRIUM OF A UNIFORMLY ROTATING AND GRAVITATING GASEOUS FLUID MASS. Cataldo Agostinelli. *Atti acad. nazl. Lincei Rend., Classe sci. fis., mat. e nat.* 26, 665-70(1959) May. (In Italian)

The equations of adiabatic equilibrium are established for a gaseous mass with infinite electrical conductivity, as a stellar mass with its high temperature rotating uniformly around its center-of-gravity axis. The mass is subjected to the mutual Newtonian attraction of the fluid particles, and it is assumed that a magnetic field is generated by the conduction current. (J.S.R.)

**4069**

ON THE ROLE OF THE RADIATION OF ADMIXTURES IN THE PLASMA ENERGY BALANCE. V. I. Kogan. *Doklady Akad. Nauk S.S.S.R.* 128, 702-5(1959) Oct. 1. (In Russian)

The role of emission from admixtures on energy balance in joule heated, pinch confined plasma system is analyzed. (R.V.J.)

**4070**

EQUILIBRIUM PROPERTIES OF A MULTICOMPONENT IONIZED GAS. Gilda Maki Harris (Univ. of California, Livermore). *J. Chem. Phys.* 31, 1211-20(1959) Nov.

A method has been developed for the calculation of the equilibrium properties of an ionized gas consisting of many nuclear and molecular species. An essential feature of the present calculation is that it explicitly considers more than one ionic species per atom and therefore applies to partially ionized atoms and molecules. Free and bound electrons are distinguished by counting as bound electrons all those in the ground state of each ionic species. Molecular species with internal degrees of freedom are also included. The additivity of kinetic and potential energy is assumed, a classical electrostatic potential of interaction is used, and electron degeneracy is included only in the kinetic energy terms. The Helmholtz free energy of the system is minimized with respect to the concentration of each species assumed present, thus determining the equilibrium composition of the system as a function of temperature and volume. The thermodynamic quantities of interest are then calculated for an appropriate temperature-volume grid. This method thus allows the effect of the variation of composition on the equation of state to be determined, as well as the delineation of regions in PVT space where the electron degeneracy and electrostatic interaction each becomes important. The present model is applied to a system of particles arising from the hydrogen molecule. (auth)

**4071**

MICROWAVE INVESTIGATION OF PLASMA IN SHOCK TUBE. Mikio Takeyama, Shiro Hamamura, and Toshiatsu Oda (Hiroshima Univ.) *J. Phys. Soc. Japan* 14, 1637-8 (1959) Nov.

The total reflection of the microwave was found to begin when the shock front reached the end of the tube. A schematic diagram of the shock microwave tube is given. (C.J.G.)

**4072**

THE QUANTUM-KINETIC EQUATION FOR A PLASMA OF SEVERAL SORTS. S. V. Temko. *Nauch. Doklady Vysshel Shkoly Fiz. Mat. Nauki* No. 2, 189-91(1958).

A quantum-kinetic equation for a system of charged particles consisting of particles of arbitrarily many sorts is arranged. Starting from the quantum equation of Temko and Klimontovich, the behavior of the single particles in a plasma of several sorts are described where only the two-sided correlation in the spatially homogeneous case is considered. The assumption is made that for a sufficiently high mean temperature of the plasma the reciprocation of the single particles one to another is small compared with the action of all charged particles together to the considered plasma particle. Under this assumption, after a convolution transformation and after the decomposition of the Fourier components of the correlation function into Fourier integrals with respect to impulses, an explicit expression for the sought quantum-kinetic equation can be obtained. (TCO)

**4073**

OSCILLATIONS IN ELECTRON-IONIC-PLASMAS. M. F. Shirokov and O. V. Prudkovskaya. *Nauch. Doklady Vysshel Shkoly Fiz. Mat. Nauki* No. 2, 192-9(1958).

A general system of equations for the motions and for the electrodynamics of a plasma which is understood as a system of charged and neutral particles is presented. The equations describe arbitrary processes in these media and set the limits for the application of the older theories of

plasma oscillations. The equations show that essentially, three kinds of oscillations exist. If the degree of charge of the plasma is not great, diffusion oscillations of the electron-ionic gas and acoustic oscillations of the neutral gas appear, otherwise there are several electro-acoustic oscillations. (TCO)

**Shielding Calculations****4074 APEX-533**

General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati.

IBM 704 PROGRAM REPORT, AIRCRAFT NUCLEAR PROPULSION SHIELDING PROGRAM 09-0. J. W. Haffner, J. J. Loechler, and J. E. MacDonald. Dec. 1959. 32p. Contracts AF33(600)-38062 and AT(11-1)-171. OTS.

Shielding program 09-0 calculates the fast neutron dose rate due to single-scattered radiation in a homogeneous, infinite medium from an anisotropic point source at any specified, unshielded point detector. The fast-neutron-source energy spectrum may be approximated by 10 energy levels. Exponential attenuation may be considered on either leg as desired. The dose rate from the source spectrum is obtained by summation of the dose rates computed for each initial energy. (auth)

**4075 NARF-59-36T**

Convair, Fort Worth, Tex.

CURVE FITS OF GAMMA-RAY DIFFERENTIAL-ENERGY SPECTRA. D. D. Babb, J. W. Keller, and E. McCray. Nov. 1, 1959. 41p. Contract AF33(600)-38946. (MR-N-251).

The results of the Nuclear Development Association (NDA) moments-method calculations of the penetration of gamma rays through various media from point-isotropic sources were interpolated and extrapolated to give differential energy spectra for a larger set of initial and final energies. For each of the new pairs of energies the data were fitted analytically and tabulated as a function of penetration distance and atomic number. The function used for the fit is:

$$\ln \frac{f(t)}{\mu_0 r} = a_1(\mu_0 r)^2 + a_2(\mu_0 r) + a_3(\mu_0 r)Z + a_4Z + a_5Z^2 + a_6$$

where  $f(t)$  is the function tabulated by NDA. The range of  $Z$  was divided into three sections and the fit made independently for each section. Thus, 18 coefficients were required for each of 104 energy pairs. (auth)

**Theoretical Physics****4076**

ON THE THEORY OF A SUPERFLUID NUCLEON GAS.

Yu. V. Tsekhmistroenko. *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* 23, 910-11(1959) July. (In Russian)

A system of interacting neutrons and protons is studied assuming that forces acting between the nucleons are central and the number of protons varies from the number of neutrons. It is revealed that in spite of their interaction, in respect to superfluidity, they act as two completely independent Fermi systems. (R.V.J.)

**4077**

ON THE THEORY OF SUPERFLUIDITY OF NUCLEAR MATTER. B. B. Dotsenko (Inst. of Physics, Academy of Sciences, USSR). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* 23, 914-17(1959) July. (In Russian)



N. A. Bogolyubov's method in the theory of super conductivity is used in developing a model Hamiltonian for Fermi particles with  $\sigma$  spin and isotopic spin  $\tau$ . (R.V.J.)

4078

STATISTICAL THEORY OF NUCLEAR POTENTIAL IN "EFFECTIVE" MASS APPROXIMATION. L. Rapoport and S. Kadomenskiĭ (Vorenezh State Univ.). *Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz.* 23, 918-23(1959) July. (In Russian)

An attempt is made, based on statistical theory, to estimate the depth and shape of a potential acting on a nucleon in a nucleus and to find the magnitude and dependence of its "effective" mass on the distance between the nucleon and the nuclear center, considering the finite dimensions of the nucleus and Coulomb forces between protons. (R.V.J.)

4079

ON THE QUESTION ON THE INDEFINITE METRIC IN THE QUANTUM FIELD THEORY. N. N. Bogolyubov, B. V. Medvedev, and M. K. Polivanov. *Nauch. Doklady Vysshei Shkoly. Fiz. Mat. Nauki* No. 2, 137-42(1958).

The theory in which the physical states with a positive norm are completed by unphysical states with a negative norm are investigated. The possibilities resulting in the theory are considered by the introduction of an indefinite metric. The field is represented as a sum of a physical field  $\psi(x)$  and a number of fictive fields  $\phi_n(x)$ . The corresponding state space  $H$  then is divided into a subspace  $H_1$  containing only the physical particles of the type  $\psi$ , and into its orthogonal complement  $H_2$ :  $H = H_1 + H_2$ . The arising specific difficulty (appearance of unphysical states in the asymptotic expressions of observed magnitudes) demands certain restrictions. Proposals referring to this have already been given. A third possibility was also investigated by assuming that every amplitude consists of a physical and a non-physical part, where the non-physical part  $F$  is determined uniquely by the physical part  $\varphi$ . A physical dispersion matrix  $\tilde{S}$  is defined by  $\varphi_+ = \tilde{S}\varphi_-$ , where  $\varphi_{\pm}$  is the state of  $\varphi$  for  $t = \pm\infty$ , and it is shown that under certain additional postulates  $\tilde{S}$  is unitary and the states of  $H_1$  form a complete system for it so that no transitions from  $H_1$  into  $H_2$  are caused by it. The proposed method is discussed by an example of the classical mechanics. (TCO)

4080

ASYMPTOTIC BEHAVIOR OF THE MATRIX ELEMENTS IN THE TWO-CHARGE-MESON THEORY. I. F. Ginzburg. *Nauch. Doklady Vysshei Shkoly Fiz. Mat. Nauki* No. 2, 152-7(1958).

The asymptotic behavior of the matrix elements of the  $S$ -matrix during arbitrary processes for large impulses:  $|p, p_k| \gg m^2$ , in connection with the pseudoscalar meson theory are investigated. It is assumed that  $b$  bosons and  $2f$  fermions ( $b + 2f = n + 1$ ) with the impulses  $p_1, \dots, p_{n+1}$ ,  $\sum_{i=1}^{n+1} p_i = 0$  have a share in the considered process. The behavior of matrix elements  $M_n$  is considered in the cases  $|p| \rightarrow \infty$ , and  $p_i^2 \rightarrow \infty$ . At first the behavior in the first non-vanishing approximation of the theory of perturbation is determined. Then numerous corrections are introduced. (TCO)

4081

THEORY OF MANY-PARTICLE SYSTEMS. [PART] I. Paul C. Martin and Julian Schwinger (Harvard Univ., Cambridge, Mass.). *Phys. Rev.* 115, 1342-73(1959) Sept. 15.

The macroscopic properties of the spectra of many-particle systems are described. Asymptotic evaluations

are performed which characterize these macroscopic features in terms of intensive parameters, and the relationship of these parameters to thermo-dynamics is discussed. The special characteristics of the ground state are shown to follow as a limiting case of the asymptotic evaluations. The time-dependent field correlation functions, or Green's functions, which describe the microscopic behavior of a multiparticle system are defined, and related to intensive macroscopic variables when the energy and number of particles are large. Spectral representations and other properties of various one-particle Green's functions are derived. The treatment of non-equilibrium processes is considered. As a particular example, the electromagnetic properties of a system are expressed in terms of the special two-particle Green's function which describes current correlation. The discussion yields specifically a fluctuation-dissipation theorem, a sum rule for conductivity, and certain dispersion relations. The boundary conditions that characterize the Green's function equations are exhibited without reference to adiabatic decoupling. A method for solving the equations approximately, by treating the correlations among successively larger numbers of particles, is considered. The first approximation in this sequence is shown to yield a generalized Hartree-like equation. A related, but rigorous identity for the single-particle Green's function is then derived. A second approximation, which takes certain two-particle correlations into account, is shown to produce various additional effects: the interaction between particles is altered in a manner characterized by the intensive macroscopic parameters, and the modification and spread of the energy-momentum relation come into play. Compact formal expressions for the Green's functions and other physical quantities are derived. Alternative equations and systematic approximations for the Green's functions are obtained. (auth)

4082

CONSTRUCTION OF THE PERTURBATION SERIES FOR TRANSITION AMPLITUDES FROM THEIR ANALYTICITY AND UNITARITY PROPERTIES. Stanley Mandelstam (Univ. of California, Berkeley). *Phys. Rev.* 115, 1752-62 (1959) Sept. 15.

The analyticity properties of transition amplitudes are used in conjunction with the unitarity requirements to generate successive terms in the perturbation series, without referring to a specific Lagrangian. In the sixth and higher orders, production is neglected in the unitarity condition; subject to this approximation, it is found that the series can be so constructed. No analyticity properties which have not been rigorously proved need be employed, and the terms are found to satisfy the double dispersion representation. By examining the connection between this method and the conventional calculation of the perturbation series, the types of spectral function corresponding to different Feynman diagrams can be found. Formulas are given for the regions in which the spectral functions are nonzero. (auth)

## REACTOR TECHNOLOGY

### General and Miscellaneous

4083 AECU-4489

General Atomic Div., General Dynamics Corp., San Diego, Calif.

BURNUP CALCULATION METHOD FOR NON-UNIFORM

FLUX AND/OR FOR MOVABLE FUEL. R. T. Shanstrom. July 7, 1958. 15p. ADDENDUM. Sept. 10, 1958. 3p. Project 40. (GAMD-425 and Add.). OTS.

This report and addendum were issued separately, but are cataloged as a unit.

A method is described which permits calculation of the attainable burnup in reactors with spatially varying flux and for various methods of moving the fuel in the reactor during irradiation. (J.R.D.)

**4084** AECU-4503

Massachusetts Inst. of Tech., Oak Ridge, Tenn. Engineering Practice School.

DRYING OF CHARCOAL USED FOR ADSORPTION OF GASEOUS FISSION PRODUCTS FROM HOMOGENEOUS REACTORS. J. M. Funderburg and L. I. Moss. Dec. 20, 1957. 16p. [For Oak Ridge Gaseous Diffusion Plant, Tenn. Contract W-7405-eng-26, Subcontract No. 70]. (KT-307) OTS.

Drying methods for charcoal adsorption beds used for removal of radioactive gases from homogeneous reactor waste are investigated to determine the method which requires the least time and apparatus. An additional objective is to prepare the charcoal for long holdup times. It was found that the limiting mechanisms of mass transfer are diffusion in the case of water, and transport to the particle vicinity in the case of krypton adsorption. Drying at 100°C is recommended. Avenues for further investigations are suggested. (J.R.D.)

**4085** AFSWC-TN-59-19

Air Force Special Weapons Center, Kirtland AFB, N. Mex. RESULTS OBTAINED USING AN IBM 704 PROGRAM FOR COMPUTING  $U^{235}$  FISSION-PRODUCT POPULATIONS, ACTIVITIES AND POWERS. Thomas B. Kerr and Roddy B. Walton. Aug. 1959. 69p. Project No. 7809.

The theory, flow diagrams, decay chain assignments, and operating instructions for an IBM 704 Program for calculating the fission product inventories for  $U^{235}$  fueled reactors are presented. Comparisons of  $U^{235}$  fission product decay power and activity between this program and the Way-Wigner equation for cyclic operation are made for a number of cyclic reactor histories. A graph is presented showing the ratio of the gamma power from each of four arbitrarily chosen energy ranges to the total gamma power as a function of time after  $10^{23}$  fissions. The ratio of fission-product beta power to gamma power for several histories is also graphically presented. Gross fission product properties and the individual isotopic activities after twenty-one cycles are listed. (auth)

**4086** ANL-6019

Argonne National Lab., Lemont, Ill.

PROTOTYPE BOILING WATER REACTOR. J. M. Harrer, ed. Oct. 1959. 79p. Contract W-31-109-eng-38. OTS.

Design of a nuclear power plant of 50-Mw(e) capacity which can be used to demonstrate advanced performance concepts for boiling water reactors is described. Included are diagrams and data on core design, mechanical design, and heat transfer and fluid flow. Also included are sections containing information on physics, fuel cycle evaluation, and recommendations. 26 references. (J.R.D.)

**4087** ARF-4132-11

Illinois Inst. of Tech., Chicago. Armour Research Foundation.

STUDIES OF REACTOR CONTAINMENT. Summary Report No. 1 [Covering Period] February 1, 1959 to July 31, 1959. T. A. Zaker, ed. Aug. 1, 1959. 74p. Contract AT(11-1)-528. OTS.

The program consists of fundamental theoretical and experimental studies directed toward the development of design criteria or codes applicable to the construction of nuclear reactor structures to prevent damage or radioactive contamination of surroundings in the event of accidental runaway or other malfunctioning of the reactor systems. The eventual development of a handbook of design for safety of reactors is visualized. Areas of research include pressure wave propagation in boiling water, design procedures for blast shields, channeling of energy in explosions at interfaces, interface reflection study for reactor containment analysis, shock crushing of reactor shield materials, explosive decompression of water resulting from pressure vessel rupture, explosives test evaluation of blast shields and blast shield materials for nuclear reactors, and design criteria for external containment structures. Current activities in each problem area are described and significant results are indicated. Several objectives of the program are presented and the organization of the program is discussed. (W.D.M.)

**4088** BAW-109

Babcock and Wilcox Co. Critical Experiment Lab., Lynchburg, Va.

LYNCHBURG TEST REACTOR—CRITICAL EXPERIMENT HAZARD EVALUATION. T. C. Engelder and P. F. Schutt. Nov. 1959. 103p. OTS.

The hazards associated with the operation of the Lynchburg Test Reactor (LTR) critical experiments are summarized. The LTR critical experiment program is outlined and the design of the experiment is described. It is proposed to construct a basic assembly of MTR-type fuel elements and Be reflector elements, with four 6 in.<sup>2</sup> test holes, normally filled with Al. The critical mass and extensive flux distributions will be obtained with shim rods in and out and with simulated test loops inserted in the test holes. The experiments will provide basic data to check two-dimensional calculational methods and provide information needed in the design of the LTR. The experiments will be performed in the LPR, using the LPR fuel elements, control system, and instrumentation. Described in detail are operating procedures, normal operating hazards, health physics procedures, and steps to be taken in the event of unusual conditions. The Laboratory Emergency Plan is described, and operating limitations are stated. Various accidents are discussed, and the maximum credible accident is postulated as the sudden addition of 2% excess reactivity coincident with the plugging of some coolant channels and melting of some of the fuel. The release of volatile fission products from the pool and laboratory building is calculated under various conservative assumptions. It may be concluded that a 2% excursion would not endanger the nearest permanent resident off the site or the employees outside the laboratory. (auth)

**4089** LAC-147

Lockheed Nuclear Products, Marietta, Ga.

RADIATION EFFECTS REACTOR SAFEGUARDS. [195?]. 271p.

Detailed information is given concerning the population and industrial distribution and the meteorological, geological, hydrological, and seismological features of the Georgia Nuclear Aircraft Facility site. Descriptions of the buildings housing the Radiation Effects Reactor, the RER operations building, the Critical Experiment Facility, and all the supporting facilities are included. A detailed description of the 10 Mw RER including components and equipment is given. Reactor physics and engineering considerations affecting the reactor core design are treated.



Some of the more important safety features being provided for at the site as well as those included in the design of the RER are covered. Conceivable reactor accidents and hazards are evaluated. (W.D.M.)

**4090** NAA-SR-3808

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

REACTOR KINETICS: A BIBLIOGRAPHY. M. Bloomfield and F. G. Bennet, IV. Nov. 1, 1959. 55p. Contract AT(11-1)-GEN-8. OTS.

A bibliography covering the material listed in Nuclear Science Abstracts and Abstracts of Classified Reports up to July 1958 is presented. It is divided into 39 sections with author and report number indexes and a glossary of abbreviations. Each subject group has the entries by author order, or by title (if no author listed). Each entry has a number so as to assist the location of reports from either the author or number indexes. While this bibliography includes classified reports (indicated by AEC Classified), there are no classified titles. Publication dates of reports are given, when available, except where a date shows in the title, such as in progress reports. The report number index may be of special value to those researchers who desire all of one company's reports on this subject. (auth)

**4091** NAA-SR-4184

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

NEUTRON FLUX DISTRIBUTIONS IN ORGANIC MODERATED REACTOR CORES. V. A. Swanson. Nov. 15, 1959. 17p. Contract AT(11-1)-GEN-8. OTS.

Neutron distribution calculations in some typical organic-moderated lattices were measured and compared with distributions calculated by the methods now in use. In addition, neutron diffusion in the moderator was studied, and some estimates of the critical sizes of the lattices that were assembled were made. The experiments were performed in a 4-ft. diam. Cd-covered Al tank placed on the graphite thermal column of the AE-6 water boiler reactor. The organic moderator used in the experiment had a chemical composition of 25% diphenyl, 54.1% orthoterphenyl, 13.1% meta-terphenyl, 0.9% paraterphenyl, and 6.9% other polyphenyls. The geometry of the fuel elements are shown as a 5.25 in. square by 61 in. long, including the centering pin and lifting eye bolt. The fuel elements consisted of either 10 or 12 Al-clad 1.875 wt. % enriched U fuel plates, 54 in. long, 5 in. wide, and 0.10 in. thick. (W.L.H.)

**4092** NAA-SR-Memo-1854

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

APPROXIMATE SOLUTIONS OF THE REACTOR KINETIC EQUATIONS FOR ONE GROUP OF DELAYED NEUTRONS. G. W. Rodeback. Feb. 21, 1957. 17p. OTS.

When reactivity is a function of time, the one-delayed-neutron-group equations can be expressed as a single second order homogeneous differential equation with variable coefficients. Some types of reactivity inputs are such that an accurate solution to this equation can be obtained with the use of "Liouville's Approximation." The method of solution is described and applications to three types of reactivity inputs are shown. (auth)

**4093** NAA-SR-Memo-4101

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

PRELIMINARY CRITICALITY AND FLUX DISTRIBUTION CALCULATIONS FOR THE U-10 w/o Mo. REFERENCE

DESIGN FUEL ELEMENT LOADING OF THE HNPf CORE USING THE MARK A CONTROL ROD SCHEME. J. B. Smathers and H. Rood. July 20, 1959. 21p. OTS.

Criticality and flux distribution calculations were made, as a function of enrichment, for the U-10 wt. % Mo reference design fuel element loading of the HNPf core, Mark A control rod scheme. A U enrichment to serve as a basis for further detailed studies of the core nuclear performance characteristics was selected. A plot was made of  $K_{eff}$  vs. enrichment for U enrichments between 2.5 at. % and 4.0 at. %  $U^{235}$ . From a study of this plot and preliminary estimates of the excess reactivity requirements of the core, the 3 at. % enriched U case was selected for further study. Nuclear characteristics of the 3 at. % enriched case are presented. (W.L.H.)

**4094** NP-8063

Norway. Institutt for Atomenergi, Halden.

SUMMARY OF THE HBWR REACTOR PHYSICS EXPERIMENTS. H. Ager-Hanssen, G. Apelqvist, P. Blomberg, K. Bryhn-Ingebrigtsen, C. F. Højerup, G. Ingram, and N. Standal. [1959]. 17p.

The reactor physics experiments were carried out with a core consisting of 124 fuel elements and were designed to yield information on the operation of the second charge. Measurements on the  $D_2O$  reflector savings and the fast neutron attenuation of the reflector were made. Reactivity effects of rod removal, water level coefficient, and temperature coefficient at room temperature were determined. The critical water height was measured as a function of fuel investment and based upon these measurements an attempt was made to arrive at a power reactivity budget for various fuel investments. (W.D.M.)

**4095** ORNL-2849

Oak Ridge National Lab., Tenn.

THE FAST MULTIPLICATION EFFECT OF BERYLLIUM OXIDE IN REACTORS. W. Häfele and M. Tsagaris. Dec. 14, 1959. 17p. Contract W-7405-eng-26. OTS.

The net multiplication effect of beryllium oxide, which is due to the  $(n,2n)$  reaction, was calculated using an essentially exact calculation of the neutron spectrum as a function of energy. The upper limit of the  $(n,2n)$  cross section curve gives the unpoisoned value  $\epsilon^+ = 1.047$  and the lower limit gives  $\epsilon^- = 1.027$ . The behavior of the  $Li^6$ -poisoned fast multiplication effect as a function of the number of collisions was studied for both beryllium and beryllium oxide. (auth)

**4096** SCR-86

Sandia Corp., Albuquerque, N. Mex.

GAS-COOLED REACTORS; BIBLIOGRAPHY. William H. Richardson and Frances Strachwitz, comps. Sept. 1959. 214p. OTS.

A compilation of 517 references to the unclassified literature to May 1959 on gas-cooled reactors is presented. It includes articles, reports, books, and patents. Reactors cooled by air are included, as well as all types of reactors by function—power reactors, research reactors, design studies, and prototypes. (W.D.M.)

**4097**

ADVANCED REACTOR CONCEPTS FOR NUCLEAR PROPULSION. Frank E. Rom (NASA Lewis Research Center, Cleveland). Astronautics 4, No. 10, 20-2; 46; 48; 50(1959) Oct.

The potential of nuclear energy in reactor concepts for rockets is discussed. The limitations of ceramics, graphite, hafnium, tantalum, and tungsten for use in high-temperature solid-fuel-element reactors are described. The use of rotating reflector drums for power control is

discussed. Liquid-uranium compounds, perhaps uranium carbide, are suggested for heating hydrogen which will then be used to produce thrust. Possibilities for producing larger forces on the uranium atoms than the hydrogen atoms are magnetic or electric fields and a vortex field flow. Designs are given for graphite, tungsten-184, and tungsten-184 and hafnium carbide multipass solid-reactor rockets; a uranium carbide liquid-reactor rocket; and a gaseous-vortex-reactor rocket. (C.J.G.)

#### 4098

GASEOUS-CORE NUCLEAR ROCKETS. Jerry Grey (Princeton Univ., N. J.). *Astronautics* 4, No. 10, 23-5; 110; 112(1959) Oct.

Several designs are presented for gaseous-core rocket systems. Methods for containing fissioning fuel are; a "magnetic bottle," a hydrodynamic "centrifugal separator," and rotating magnetic fields to spin the mass of hot ionized fuel. Heat-transfer limitations of the cavity reactors are discussed. The principle of the bomb-powered rocket, known as Project Orion, is illustrated. Full utilization of the exothermic nuclear fusion process, which eventually forms helium from reactions between deuterons, is discussed. (C.J.G.)

#### 4099

SOLID-CORE NUCLEAR-ROCKET DESIGN. Franklin I. Durham (Los Alamos Scientific Lab., N. Mex.). *Astronautics* 4, No. 10, 26-7; 102-4(1959) Oct.

The primary problems involving the structural design of the solid-core nuclear-rocket are described. The heat exchanger requirements are discussed. Expressions are given for calculating the approximate core pressure drop, elastic thermal stresses in fuel elements, heat-transfer coefficients for a given passage and flow rate, and thermal and neutronic time constants. Design problems in non-nuclear components such as reactor pressure shell, propellant nozzle, and the control actuators are considered. (C.J.G.)

#### 4100

ENGINEERING HOT-CHANNEL FACTORS. B. W. Le Tourneau and R. E. Grimble (Westinghouse Electric Corp., Pittsburgh). *Chem. Eng. Progr.* 55, Symposium Ser. No. 22, 1-8(1959).

In the thermal design of nuclear power reactors having parallel coolant channels, engineering hot-channel factors are established to account for small dimensional deviations from the nominal design of the reactor fuel elements resulting from manufacturing tolerances and for departures from ideal flow conditions. Various deviations from nominal design which are likely to be encountered in a practical reactor design are described, together with methods of estimating the magnitude of the effect of each on channel enthalpy rise, film temperature difference, and maximum heat flux. Examples are given for a geometry consisting of parallel plate-type fuel elements separated by rectangular coolant channels. (auth)

#### 4101

AN IN-PILE STUDY OF ORGANICS AS NUCLEAR REACTOR COOLANTS. Malcolm McEwen and Edward W. Wiederhold (Monsanto Chemical Co., Dayton, Ohio). *Chem. Eng. Progr.* 55, Symposium Ser. No. 22, 9-15(1959).

A preliminary engineering study to determine the feasibility of using organic chemicals as nuclear reactor coolant-moderators was made for biphenyl; the tertiary eutectic mixture of biphenyl, *o*-terphenyl and *m*-terphenyl; HB-40, a partially hydrogenated mixture of the terphenyl isomers; and monoisopropylbiphenyl. A test loop was de-

signed and operated to determine for these organics the specific radiolytic-decomposition rate, gas-generation rate, induced-radioactivity levels, and effect of decomposition products on the operating characteristics of the system and on the engineering properties of each material. (auth)

#### 4102

THE INSIDE-OUT REACTOR. Milan Osredkar and Richard Stephenson (New York Univ.). *Chem. Eng. Progr.* 55, Symposium Ser. No. 22, 17-18(1959).

A reactor design is given which consists of a central moderator region which is surrounded by fuel. The various geometries investigated are illustrated. The fuel systems vary from pure  $U^{235}$  down to a  $U^{235}-H_2O$  ratio similar to that of the MTR. Light water, heavy water, and a mixture of the two were used in the central moderator region. (C.J.G.)

#### 4103

USE OF A NUCLEAR REACTOR AS A PROCESS HEAT SOURCE. R. W. Ritzmann (U. S. Atomic Energy Commission, Washington, D. C.). *Chem. Eng. Progr.* 55, Symposium Ser. No. 22, 19-24(1959).

Possible methods of using a nuclear reactor as the endothermic-chemical-reaction heat source in a coal-gasification plant are discussed. The most feasible method appears to be that of having the nuclear reactor produce 3,000°F steam, which is fed to the chemical process. The economics of this method are discussed, and charts showing the effects of steam temperature and heat recovery on the threshold economics are presented. The cost of heat produced by a nuclear reactor is estimated to be \$1.12/MM Btu. This compares with the threshold cost of \$1.32/MM Btu for heat supplied by the conventional method of burning coal with oxygen. (auth)

#### 4104

A PRUDENT CALCULATION OF THE START-UP INCIDENT IN A REACTOR. A. Ascari (SORIN, Milan). *Energia nucleare (Milan)* 6, 702-6(1959) Nov. (In Italian)

A consistent account is given of the theory of the start-up incident, leading to the result known as "Newson's inequality." The treatment is completed with some less known results on the height of the power excursion and the amount of the energy release in the incident. (auth)

#### 4105

THE CHEMICAL INDUSTRY — A NUCLEAR FUTURE? PART III. NUCLEAR ENGINEERING. W. R. Tomlinson, Jr. (Johns Hopkins Univ., Bethesda, Md.). *Ind. Eng. Chem.* 51, 1435-40(1959) Dec.

A review is presented on reactor design factors. Reactor control through varying the effective multiplication factor,  $k_{eff}$ , is discussed. Expressions for calculating  $k_{eff}$  under various conditions are given. Expressions are given for heat transfer from fuel elements to the coolant. (C.J.G.)

#### 4106

CORROSION BY COOLING GAS IN NUCLEAR REACTORS. R. Darras (Commissariat à l'Énergie Atomique, Paris). *Inds. atomiques* 3, No. 9-10, 41-61(1959). (In French)

The construction materials and cooling gases used in reactors are reviewed with regard to dry corrosion. Generalities on dry oxidation of metals and alloys are offered with particular attention to diffusion, diffusion mechanisms, and methods for studying diffusion. The materials discussed include U and its oxides, carbides, and silicides, Mg, Al, Zr, Be, stainless steel, and ceramics, ordinary steels, low-alloy steel, graphite, and  $BeO$ . Recommendations for future studies are made in conclusion. (T.R.H.)



4107

GAMMA COMPENSATED IONIZATION CHAMBERS FOR REACTOR CONTROL. A. L. Gray (Plessey Nucleonics Ltd., Northampton, Eng.). Nuclear Power 4, 112-16(1959) Dec.

The design problems of gamma compensated ionization chambers for use at low flux levels are discussed. The designs of American, British, and Russian chambers are given and compared. The coaxial cylinder geometry seems to offer the best hope of making a chamber insensitive to gamma flux without excessive complication. The applications and limitations of the chambers are given. (C.J.G.)

4108

A THERMOCOUPLE FOR REACTOR CONTROL. J. L. Ayre (Simon Carves Ltd., Eng.). Nuclear Power 4, No. 44, 117-18(1959) Dec.

The design is given of chromel-alumel thermocouples which are sheathed in stainless steel and housed in a concentric radiation shield which in turn is housed in a recess on the side of the channel. An angle of  $15^\circ$  to the channel axis was found to ensure entry of the gas stream into the pocket and a  $20^\circ$  angle would be suitable to return the flow to the channel. The designs obtained from air-rig and water model tests are discussed. (C.J.G.)

4109

CONTROL-ROD DRIVE FOR HTGR's. C. A. Kroeber and J. M. Welch (Ford Instrument Co., Long Island City, N. Y.). Nucleonics 17, No. 12, 110(1959) Dec.

A design is given for a control-rod drive for high-temperature gas-cooled reactors. Each control rod is individually driven by means of a rack and pinion at its lower end. The energy of the falling rod is absorbed through the use of a ball-nut-hydraulic cylinder arrangement. (C.J.G.)

4110

IMPROVEMENTS IN OR RELATING TO CONTROL SYSTEMS FOR NUCLEAR POWER PLANTS. Eric Anderson (to Parolle Electrical Plant Co., Ltd.). British Patent 823,429. Nov. 11, 1959.

A control scheme is presented for nuclear power plants in which steam generated in a secondary circuit drives a turbine. When power demand falls, steam pressure rises activating switches to reduce primary coolant flow imposing a temperature difference between reactor inlet and outlet. As a result of the negative temperature coefficient of the reactor, the multiplication constant decreases and thermal power drops. The power decrease causes the temperature difference to decrease reducing the negative temperature coefficient effect and, consequently, reducing the rate of change of power. The control rods operate to maintain constant outlet temperature, and the system continues in this state until the initial pressure conditions at the heat exchanger or initial temperature conditions at the reactor outlet are restored. (T.R.H.)

## Research Reactors

4111 ANL-5928

Argonne National Lab., Lemont, Ill.  
TERMINAL REPORT ON THE MIGHTY MOUSE HIGH-FLUX RESEARCH REACTOR PROJECT. L. E. Link, R. H. Armstrong, T. C. Cameron, R. F. Dickson, J. B. Heineman, C. N. Kelber, P. H. Kier, H. F. Reed, R. R. Rohde, J. P. Simon, and W. R. Ware. Sept. 1959. 217p. Contract W-31-109-eng-38. OTS.

The research and development program pertinent to the conceptual design and ultimate construction at ANL of

an advanced research reactor with a peak thermal flux of  $5 \times 10^{15}$  n/cm<sup>2</sup>/sec is documented. The basic reactor complex, the problems involved, the various approaches pursued, the present status and estimated cost of the project, along with recommendations for future research and development essential to the successful culmination of the project are described. The reactor is moderated with D<sub>2</sub>O and has a core life of 120 hours at 250 Mw. (W.D.M.)

4112 CF-59-9-7

Oak Ridge National Lab., Tenn.  
ORR EXPERIMENTAL FACILITIES. A. R. Boynton. Sept. 1, 1959. 38p. OTS.

Experimental facilities of the ORR are described. Dimensioned drawings are included as well as tables of reactor and facility properties. (J.R.D.)

4113 UVAR-8 (and Amendments 1 and 2)

Virginia. Univ., Charlottesville. School of Engineering. THE UNIVERSITY OF VIRGINIA REACTOR: DESCRIPTION AND OPERATION. J. L. Meem. Sept. 22, 1958. (Includes Amendments 1 and 2). 131p.

A detailed description of the University of Virginia Reactor is given. The reactor is a one megawatt swimming pool with an excess reactivity of 2% for full power experiments. Containment is provided to withstand  $\frac{1}{2}$  lb/in.<sup>2</sup> positive pressure within the reactor room. Details are given on the operating procedures and the research and training program. The reactor consists of MTR type fuel elements mounted on an aluminum bottom grid plate with the structure suspended from a movable bridge above the pool. (W.D.M.)

4114

HIGH PRESSURE WATER LOOP IN DIDO. I. Everson (Atomic Energy Research Establishment, Harwell, Eng.). Nuclear Power 4, No. 44, 103-8(1959) Dec.

The design and construction features of the high-pressure water loop in Dido are given. The location of the loop relative to the reactor is illustrated and a simplified flowsheet is presented. A description of the safety features and commission tests are given. (C.J.G.)

## Power Reactors

4115 ACNP-5921

Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee. PATHFINDER ATOMIC POWER PLANT FINAL REPORT MOISTURE DE-ENTRAINMENT TESTS IN TWO- AND FOUR-INCH DIAMETER TEST SECTIONS. J. Wilson and M. McDermott. Nov. 15, 1959. 24p. For Northern States Power Co. and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. OTS.

Tests are described to determine the amount of entrained moisture occurring in the steam of the Pathfinder Power Plant as design parameters were varied. It was found that the height of the moisture separator and the velocity of the steam should be adjusted so that the permissible steam velocity for the particular height is not exceeded. If this is done, the amount of moisture entering the separator should be less than 1%, an amount of moisture that should not be difficult to remove with moisture separators. (J.R.D.)

4116 ANL-6063

Argonne National Lab., Lemont, Ill.  
LECTURE NOTES ON HEAT EXTRACTION FROM BOILING WATER POWER REACTORS. P. A. Lottes, M. Petrick, and J. F. Marchaterra. Oct. 1959. 172p. Contract W-31-109-eng-38. OTS.

Presented at the Advanced Summer Institute at Kjeller, Norway, August 17-29, 1959.

Calculation procedures for the thermal and hydraulic performance of boiling reactors are outlined relative to boiling heat transfer, evaporator-condenser heat transfer, fuel element heat transfer, and steam heat transfer equations. Various engineering systems for evaluating the two-phase pressure drop are given; the corrected Martinelli-Nelson method was found most adequate. Working curves for calculating velocity ratios and steam volume fractions are given which are accurate to within  $\pm 15\%$ . Expressions are given for calculating pool and film boiling and net and local boiling burnout for various geometrical arrangements. Calculation procedures are given for natural and forced circulation system analysis and compared to experimental data. Design criteria are discussed with calculation procedure given for the design parameters: moderator to fuel ratio, critical maximum heat flux, vapor-liquid separation, and reactor geometry, natural vs. forced circulation. The calculation procedure is illustrated by a sample core analysis. The physical and thermodynamic properties of light and heavy water are given. (C.J.G.)

**4117** APAE-51

Alco Products, Inc., Schenectady, N. Y.  
SM-1 RESEARCH AND DEVELOPMENT PROGRAM ACTIVITY BUILDUP PROGRAM. TASK I. Final Report for February 1958 to June 1959. William S. Brown, C. Richard Bergen, Carl A. Bergmann, Julius Chupak, Susanne R. Fitzsimmons, and Louis G. Grant. Aug. 10, 1959. 204p. Contract AT(30-3)-326. OTS.

The results of activity buildup studies in the SM-1 (APPR-1) performed from February 1958 to January 1959 are reported. Data are presented on the extent, nature, and mechanism of the buildup of long-lived gamma emitting nuclides in the reactor primary system. Mathematical equations to describe the activity buildup are derived. Radiation levels after reactor shutdown are presented, as well as the predicted radiation levels at the end of core life. (auth)

**4118** APAE-Memo-199

Alco Products, Inc., Schenectady, N. Y.  
BURNOUT DISTRIBUTION IN SM-1 (APPR-1) CONTROL ROD ELEMENTS, FIXED ELEMENT NO. 57 AND ABSORBER SECTIONS AT 10.5 MWYRS. P. E. McElligott. June 5, 1959. 35p. Contract AT(30-3)-326. OTS.

An analytical prediction of the burnout distributions in particular SM-1 fuel elements and absorber sections after 10.5 MWYR of core energy release is given. The distributions are based on the results of a one-shot, non-uniform burnout calculation, and are presented for both fuel and boron-10 depletion. Particular emphasis is placed on those elements removed from the SM-1 core in March 1959, since their subsequent burnup analysis by ORNL should provide a valuable check on the analytical models employed. (auth)

**4119** APAE-Memo-206

Alco Products, Inc., Schenectady, N. Y.  
SM-1 RESEARCH AND DEVELOPMENT PROGRAM; INTERIM REPORT NO. 2 ON CORE MEASUREMENTS. Task No. VII. S. D. MacKay and D. C. Tubbs. June 30, 1959. 62p. Contract AT(30-3)-326. OTS.

Physics experiments were performed on the SM-1 core. Measurements were made on five rod bank positions and rod calibrations. The reactivity effects of core modifications were investigated. Modifications to the core included replacement of the boron absorbers in rods 1, 2, 3, 4 and C with europium absorbers; replacement of a control rod fuel element with one containing an integral europium flux

suppressor; and replacement of a stationary fuel element. Additional experiments were designed to determine the reactivity of the SM-1 with 4 and 8 stationary elements removed; the neutron flux in the biological shield and in the region of an integral europium flux suppressor; and the gamma flux above the core and from irradiated control rod components. (auth)

**4120** APAE-Memo-214

Alco Products, Inc., Schenectady, N. Y.  
EVALUATION OF LOW IMPURITY CORE MATERIAL IN THE SM-2. Guyon P. Pancer and John L. Zegger. Aug. 14, 1959. 61p. Contract AT(30-3)-326. OTS.

The worth of reduced cobalt and tantalum impurity concentrations of AISI Type 347 stainless steel in the SM-2 core cladding and structural material was evaluated on the basis of material costs involved and accessibility for maintenance. (auth)

**4121** BAW-1024

Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.

LIQUID METAL FUEL REACTOR EXPERIMENT. Quarterly Technical Report for February 1957-May 1957. 127p. Contract AT(30-1)-1940. OTS.

A comprehensive test program was prepared utilizing the LMFRE general outline as a point of departure. A minimum of one year was determined for the full-power demonstration run. Work continued on the graphite development program. The concept of building the LMFRE with a full or partial blanket was considered as an alternate design. The nuclear specifications of the reference design LMFRE were calculated in spherical geometry, using the completed Spectral Code. The immediate and total temperature coefficients of the reference design were computed. The reactivity associated with various materials in the core and reflector test holes was estimated. Control rod calculations were revised. The set of fifteen differential equations representing the time behavior of the reactor power, temperature, and pressure after the introduction of reactivity was programmed and initial results obtained. Design studies indicated that on LMFRE critical experiment should be performed. A graphite core-reflector barrier reactor arrangement was selected as the LMFRE reference design. Work was accomplished on the reactor vessel, containment system, and control rods. Core thermal calculations were continued. Comparison of concretes for shielding was completed. Reactor start-up studies received consideration. Primary system components and materials were selected. The reactor building and facilities are described. Chemical considerations for the quarter were devoted to completing the LMFRE Phase I reference design for the chemical plant and associated research and test programs. The scope of chemical processing received extensive consideration throughout the conceptual design phase. Projects on chemistry, metallurgy, and other smaller laboratory test work are described. (For preceding period see BAW-1004.) (W.D.M.)

**4122** BAW-1041

Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.

LIQUID METAL FUEL REACTOR EXPERIMENT. Quarterly Technical Report [for] October-December 1957. 102p. Contract AT(30-1)-1940. OTS.

One of the six criticality calculations was run on an IBM-704 computer. Continued investigation of the effect of inelastic scattering in Bi revealed that the previously reported value is too high. Intermediate heat exchanger equations were solved in one region with satisfactory results. Conceptual design of the critical experiment was



completed. A time study of an externally cooled, single-region LMFR was accomplished. Calculations to determine the extent of U diffusion into a simulated graphite core tank were made. The number and position of core and reflector thermocouples were determined. The U concentration necessary for operation was found to be 1800 ppm at 400°C. A primary system circulation study indicated that the system pressure drop is considerably less than originally estimated. Systems were investigated for a number of different studies on both internally and externally cooled LMFR's. The operation of an LMFRE degasser that would permit the recovery of relatively pure Xe and Kr seems feasible. A large-scale power breeder LMFR is being designed as a reference for preparing the LMFRE and supporting research programs. Preliminary results of capsule equilibration tests (U solubility in Bi) indicated that good data were not obtained. Zirconium nitride film theory studies were continued. Impact tests performed on specially prepared specimens of Croloy 1 $\frac{1}{4}$  and 2 $\frac{1}{4}$ , showed erratic impact values at the lower temperatures. All of the first 60 tests scheduled for the original statistical program were completed and the results are presented. Operation of loops and test facilities is described. (See also BAW-1029.) (W.D.M.)

#### 4123 BNL-4459

Brookhaven National Lab., Upton, N. Y.  
LMFR BIMONTHLY PROGRESS REPORT, MARCH-APRIL 1959. July 7, 1959. 96p. OTS.

A study of the potential breeding gain of U<sup>233</sup>-fueled reactors was completed. Studies of the fast effect in Be were completed and indicate a value of  $\epsilon \approx 1.06$ . Studies of LMFR stability and neutron capture in Bi resonances were completed. A total of 16 different metals and alloys was tested in rocking-furnace experiments to determine their suitability for constructing fuel-salt extraction columns. On the basis of preliminary results, there appears to be a considerable mutual solubility effect between Zr and Ru in Bi solutions. A large number of gram-scale dispersions of ThO<sub>2</sub> in Bi were made under a variety of conditions. Powders produced by calcination of Th(NO<sub>3</sub>)<sub>4</sub> and Th(OH)<sub>4</sub> are more easily dispersed than those produced from Th(C<sub>2</sub>O<sub>4</sub>)<sub>2</sub>. Gram-scale dispersions of ThO<sub>2</sub> in Bi were produced by oxidizing Th dissolved in Bi with either a stream of O or by the addition of Bi<sub>2</sub>O<sub>3</sub>. Sessile-drop measurements at 500°C for Bi in contact with flat surfaces of ThO<sub>2</sub> showed contact angles ranging from 90 to 150°, and indicate very little tendency for wetting. In analytical procedures, ThO<sub>2</sub>-Bi slurries are treated with nitric acid to separate soluble from insoluble constituents. Several types of oxides were treated with boiling concentrated nitric acid for 15 min, and the soluble fraction of each determined. Bench-scale tests of ThO<sub>2</sub>-Bi dispersions are summarized. ThC<sub>2</sub>-Bi dispersions were found to be chemically unstable at LMFR temperatures, the Bi reducing the Th. In a single experiment, pure Bi and 9% ThO<sub>2</sub>-Bi slurry containing 100 ppm Mg were equilibrated with a single gas phase consisting of activated Xe at 500°C and 510 mm Hg. Heat transfer coefficients, under improved test conditions, were measured for parallel flow of Hg through staggered tube banks. On the 4-in. utility test loop, electrical and mechanical items were checked out and vacuum degassing of most of the loop was completed. Construction, outgassing, and weld heat treating of Loop H-1 was completed. (For preceding period see BNL-4261.) (W.D.M.)

#### 4124 DP-395

Du Pont de Nemours (E. I.) & Co. Atomic Energy Div.,  
Wilmington, Del.  
HEAVY WATER MODERATED POWER REACTORS. Prog-

ress Report [for] May and June 1959. L. Bernath and L. Isakoff, comps. Sept. 1959. 55p. Contract AT(07-2)-1. OTS.

Continued progress is reported on the design and construction of the Heavy Water Components Test Reactor (HWCTR), a high-temperature facility for simultaneously irradiating sizable numbers of fuel elements under power reactor conditions. In particular, the design of the normal and emergency power supply is reviewed, experimental verification of the adequacy of the control and safety rod system is given, and the fabrication of fuel tubes for the unit is discussed. Progress is also reported on several general studies of importance to the technology of heavy-water-moderated, natural-uranium-fueled power reactors. Preliminary experimental confirmation was obtained of the methods used for predicting the nuclear properties of fuel lattices that are moderated with hot heavy water. Further tests are described for the fabrication of fuel tubes of uranium metal and uranium oxide. Encouraging results continue from the irradiation test of a prototype metal fuel tube in the Vallecitos Boiling Water Reactor. The initial results of high-temperature irradiation tests on uranium metal slugs also appear satisfactory. Tests of stainless steel specimens show that a significant relaxation of stresses occurs during irradiation. (For preceding period see DP-385.) (auth)

#### 4125 DP-405

Du Pont de Nemours (E. I.) & Co. Explosives Dept.,  
Wilmington, Del.  
HEAVY WATER MODERATED POWER REACTORS. Progress Report [for] July 1959. L. Isakoff, comp. Oct. 1959. 43p. Contract AT(07-2)-1. OTS.

Continued progress is reported on the design and construction of the Heavy Water Components Test Reactor (HWCTR), a high-temperature facility for simultaneously irradiating sizable numbers of fuel elements; 65% of the firm design and 5% of the construction were complete at the end of July 1959. Further analyses are given of the response of the HWCTR system to changes in reactivity and steam valve setting. A method is described for increasing the heat transfer burnout limit for water-cooled fuel elements by roughening the heat transfer surfaces. The results of cold swaging experiments on two six-foot-long tubes of stainless-steel-clad uranium oxide are also reported. (For preceding period see DP-395.) (auth)

#### 4126 DP-415

Du Pont de Nemours (E. I.) & Co. Atomic Energy Div.,  
Wilmington, Del.  
HEAVY WATER MODERATED POWER REACTORS. Progress Report [for] August 1959. L. Isakoff, comp. Oct. 1959. 59p. Contract AT(07-2)-1. OTS.

Continued progress is reported on the design and construction of the Heavy Water Components Test Reactor; 70% of the firm design and 10% of the construction were complete at the end of August 1959. Installation of two isolated coolant loops, one cooled with boiling D<sub>2</sub>O and the other with liquid D<sub>2</sub>O, were authorized by the Atomic Energy Commission. Further study was made of the behavior of the HWCTR following unusual incidents, malfunctions, and accidents. The results of additional irradiation tests of uranium metal fuel tubes and of Zircaloy and zirconium components are reported. (For preceding period see DP-405.) (auth)

#### 4127 HW-61236

General Electric Co. Hanford Atomic Products Operation,  
Richland, Wash.  
PLUTONIUM RECYCLE TEST REACTOR FINAL SAFE-



GUARDS ANALYSIS. N. G. Wittenbrock, P. C. Walkup, and J. K. Anderson, eds. Oct. 1, 1959. 302p. Contract AT(45-1)-1350. OTS.

The Plutonium Recycle Test Reactor (PRTR) is designed to obtain experimental data on plutonium fuel technology and plutonium fuel cycle physics, and to produce irradiated fuel for the development of plutonium fuel chemical processing. Its main purpose is to provide a pilot scale demonstration of the economics and practicability of various plutonium recycle fuel concepts. The reactor complex is described in detail. The operating procedures, which are designed to maintain a high degree of reactor safety, are described. Reactor safeguards aspects of possible equipment malfunctions and failures are analyzed. (auth)

4128 NAA-SR-Memo-4156

Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.

STATUS REPORT FOR SODIUM GRAPHITE REACTORS. July 1959. 110p. OTS.

The current development status of the Sodium Graphite Reactor concept is described. The development history is summarized and all important areas of development are discussed. The discussions of the SGR development program are broken into three categories, (1) general research and development, dealing with reactor physics, fuel and materials, components, etc., (2) experimental reactors, operating, in some design phase, or under construction, and (3) power demonstration reactors, operating or in a design or construction phase. Reactors discussed include the SRE, SCRE, HNPF, SIR, and the 300 Mw Canned Moderator Reactor. (W.D.M.)

4129 ORNL-2835

Oak Ridge National Lab., Tenn.

GAS-COOLED REACTOR PROJECT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1959. Dec. 2, 1959. 178p. Contract W-7405-eng-26. OTS.

Reactor Physics: A four-group, two-dimensional, diffusion theory calculation of the power-density distribution in the EGCR was made in order to reduce the uncertainties in the results of previous calculations. A comparison was made of calculated neutron flux distributions in seven-rod fuel clusters and the preliminary results obtained in the Physical Constants Test Reactor at Hanford. Neutron flux ratios for the EGCR lattice cell were calculated for fuel enrichments of 2.0 and 2.6%. Studies were made of the power densities attainable in gas-cooled reactors operated with ceramic material as both fuel and moderator. Extensive studies were conducted to determine how the multiplication factor of a gas-cooled reactor varies with the number of rods in the fuel element cluster, cladding thickness, cladding material, inter-rod spacing, lattice pitch, solid and cored rods, fuel enrichment, and fuel-to-moderator ratio. Reactor Design Studies: A theoretical study is being conducted of the deflections and stresses in fuel element cladding based on arbitrary temperature distributions. Tests were run to determine the load-carrying ability of the threaded-pin-type graphite column joints proposed for the EGCR. A test program was initiated for studying the behavior of metal-clad graphite bodies. An analytical model for investigating temperature structure and thermal stability of a seven rod fuel element cluster was developed. Calculations were made of the natural frequencies and an amplitude of vibrations in the EGCR fuel element clusters. A parametric study was completed from which the diameter of the coolant channel, pressure drop across the core, and pumping power can be evaluated for a helium-cooled reactor fueled with  $UO_2$  clad with stainless

steel. A detailed analysis was made of the He purification system needed for limiting graphite burnup and carbon mass transfer in the EGCR. In a design study of advanced steam generators, data were obtained with which to evaluate the effects of fin height and tube diameter on the pressure vessel. Experimental Investigations of Heat Transfer and Fluid Flow: The study of heat transfer in the septafoli geometry was reoriented toward establishing the criteria for the thermomechanical stability of the tubes in a seven-tube bundle when a nonuniform circumferential temperature distribution exists. To determine whether the cross-flow indicated by the heat-transfer measurements was the result of channel inlet conditions, one of the peripheral tubes in the heat-transfer apparatus was replaced by a naphthalene-coated rod. A preliminary measurement of the velocity distribution for downstream in a septafoli channel having a  $\gamma = 2$  tube spacing was completed. Metallurgy: Compression testing of high-density  $UO_2$  has shown it to withstand loads of 5000 psi at 1500°C with only moderate deformation. Data were obtained from tube-burst tests of fuel capsule tubing at 1800°F which show that results previously reported must be corrected. A series of modified tube-burst tests was conducted to complete the evaluation of the end-closure joints. Results from strain cycling of capsule tubing indicate that temperature has no influence on the number of cycles to failure. Brazing studies on simulated spacers for the mid-plane of the fuel elements were initiated, and the optimum diametral gap between spacer and tube wall was determined. The reactions of stainless steel with low levels of contaminants in He and Ar are being studied. Welding tests were conducted on cast fuel element hanger material. Development work is being performed on reference standard defects for eddy-current inspection of tubing. Diffusion bonding and brazing of Be were studied. Evaluations of extruded tubing from England revealed considerable dimensional variation. A survey of available data on the reactions of Be with gases was completed. In-pile Testing of Components and Materials: Initial operation of the GETR helium loop revealed the need for several design changes. A new capsule was designed for LITR irradiations. The first instantaneous fission gas release experiment on  $ThO_2-UO_2$  samples was completed. The fission product release data obtained in postirradiation studies were tabulated. Investigations of irradiation effects on Pt-Pt-Rh thermocouples were carried out. Data were obtained in the study of radiation effects on structural materials. Out-of-pile Testing of Materials and Components: The program of out-of-pile tests of reactor materials compatibility and the structural integrity of fuel elements was continued. Data were collected on the evolution of gases from graphite at elevated temperatures. Apparatus was constructed for studying the process by which Kr and Xe diffuse "upstream" in He flowing through a graphite sleeve under a driving force consisting of a differential pressure. An extensive investigation of means for measuring high temperatures was initiated. A system was designed for automatic continuous analysis of He. Development of Test Loops and Components: Design work was completed and fabrication was initiated on the gas-cooled loop for operation in the ORR. Development work was continued on gas compressors and electric motors. Facilities are being developed for testing electric motors for high-temperature service. (For preceding period see ORNL-2767.) (W.D.M.)

4130 WAPD-MRP-82

Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh.

PRESSURIZED WATER REACTOR (PWR) PROJECT



TECHNICAL PROGRESS REPORT FOR THE PERIOD AUGUST 24, 1959 TO OCTOBER 23, 1959. 89p. Contract AT-11-1-GEN-14. OTS.

**Power Plant Support.** An experimental loop decontamination was carried out using the alkaline permanganate-ammonium citrate process under conditions of low flow velocity to simulate the decontamination conditions in PWR heat exchangers. **Reactor Engineering.** A pre-site functional test of the blanket shell inspection tool was completed. A series of calibration tests conducted on a prototype Seed 2 exit water connector junction was completed. A thermal performance study was made which compared three types of cores in order to establish which water channel dimensions are more desirable. **Metallurgy.** Additional in-pile conductivity measurements of  $UO_2$  pellet samples indicate that thermal conductivity is high at diametral clearances of 1.5 to 2.5 mils and is low at 3.5 to 8 mils clearance. Analysis of the low-Ni Zircaloy cladding from the X-1-N experiment showed hydrogen pickup, but no evidence of failure. Examination by pressure-bursting of irradiated plate-type oxide samples indicates retention of strength after high burnup. The use of Fe-Cu as a multiple bonding agent for diffusion-bonded oxide plate fuel elements permits a significant reduction in bonding temperature and improved corrosion resistance of bonds. Long time exposure to 680°F water of high density  $B_4C$  indicates very low weight loss. Uranium self-diffusion coefficients in  $UO_2$  were determined using the alpha surface activity decrease method. **Physics.** A selective assignment of PWR-1 Seed 2 cluster locations was chosen based upon the composition of the fabricated Seed 2 clusters. A detailed two-dimensional beginning-of-life calculation of PWR-1 Seed-1 was completed. A series of studies was carried out to investigate the relative shutdown capabilities of three different control rod configurations. Estimates of the beginning- and end-of-life static temperature coefficients of reactivity were made using both one- and two-dimensional diffusion theory solutions. Criticality measurements of the reactivity of fourteen PWR-1 Seed-2 Clusters were determined. The initial measurement of the resonance escape probability in compartmental fuel plates containing natural  $UO_2$  wafers was completed. (For preceding period see WAPD-MRP-81.) (W.L.H.)

#### 4131 WCAP-564

Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh and Pennsylvania Power and Light Co. Atomic Engineering [Dept.], Pittsburgh.

DESIGN OF A CHARCOAL BED ADSORPTION SYSTEM. D. F. Rinald. [1959?]. 10p. OTS.

Design calculations for the charcoal beds proposed for Reference Design One-A of the PAR project are presented. The method outlined is applicable to any similar adsorption system. (J.R.D.)

#### 4132 YAEC-161

Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.

QUARTERLY PROGRESS REPORT FOR THE PERIOD APRIL 1 TO JUNE 30, 1959. H. E. Walchli. Aug. 15, 1959. 88p. For Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1. OTS.

A technical description of the research and development work accomplished and the progress made during the report period are given. An evaluation and the resulting conclusions of the work performed are given for each project in which definitive progress was made. Investigation of effects on stainless steel tubing due to phosphorus from brazing materials indicated that ductility changes are not

excessive. Post irradiation examination revealed cracking of pellets with no gross dimensional changes. Nickel was successfully bonded to Ag-In-Cd control rod material through plating and heat treating. Analysis of complete loss of coolant flow reveals that core clad temperature does not exceed allowable values under this condition. Galvanic attack was found to be present between various materials of construction and stainless steel in water containing boric acid and oxygen. Attack was reduced by use of dianodic phosphate and chromate inhibitors. The magnetic jack positive latch control rod drive mechanism was shown to exceed design expectations for speed, capacity, and life expectancy under abnormal crud conditions. Experimental results from hydraulic flow tests on a model reactor vessel were in generally good agreement with calculated and predicted results. The latest nuclear, mechanical, and thermal design data for the core are given. A brief report on the two region critical experiments using Yankee CRX and BR-3 fuel is given. (For preceding period see YAEC-125.) (W.D.M.)

#### 4133 YAEC-171

Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh.

MONTHLY PROGRESS REPORT FOR THE PERIOD OCTOBER 1 TO 31, 1959. H. E. Walchli. Nov. 20, 1959. 13p. For the Yankee Atomic Electric Co. Contract AT(30-3)-222, Subcontract No. 1. OTS.

Brief reports are given of work on mechanical design, thermal and hydraulic design, control rod development, and radiation damage experiments. (For preceding period see YAEC-168.) (W.L.H.)

#### 4134

REPORT ON PROCESS STEAM REACTORS. E. L. Heller and D. O. Hubbard (H. K. Ferguson Co., Cleveland). Chem. Eng. Progr. 55, Symposium Ser. No. 22, 91-7(1959).

The design of a pressurized-water reactor to produce 135,000 lbs of 150-lb gauge saturated steam/hr (40-Mw reactor heat output) is given. The core requires 10 kg of fully enriched  $U^{235}$  and would last about 6 months with a 30% burn-up. A blanket with 1.7 tons of natural  $UO_2$  is proposed, having a life of about 5,000 Mw-days/ton. Descriptions are given of reactor shell and containment, instrumentation and safety controls, pumps, piping, and water treatment facilities. The capital investment and operating costs of the process steam reactors are compared to the conventional coal-fired plant. (C.J.G.)

#### 4135

INDIRECT CYCLE NUCLEAR REACTOR SYSTEM TO FURNISH PROCESS HEAT. R. Carson Dalzell (U. S. Atomic Energy Commission, Washington, D. C.) and James P. McGee (Bureau of Mines, Washington, D. C.). Chem. Eng. Progr. 55, Symposium Ser. No. 22, 111-18 (1959).

A system using the indirect cycle consists essentially of a nuclear reactor to heat the gaseous heat transfer medium, a high-temperature heat exchanger to transfer heat from the gas to the process streams, and a recycle compressor to recirculate the carrier gas. Factors influencing the design of a process heat reactor are given and various components of the reactor system are described. The use of a nuclear reactor to furnish the process heat required for gasifying coal is discussed. (C.J.G.)

#### 4136

HIGH-OPERATING-TEMPERATURE REACTOR DESIGN. Joseph DeFelice (Nuclear Development Corp. of America, White Plains, N. Y.). Chem. Eng. Progr. 55, Symposium Ser. No. 22, 159-65(1959).

A design is presented of the High Operating Temperature Reactor (HOTR). The HOTR consists of an inner, helium-cooled, high-temperature region and an outer, water-cooled, low-temperature region. Helium enters the hot zone at 1000°F and leaves at 2500°F while the water leaves the aluminum-clad U<sup>235</sup> alloy fuel elements at 170°F. The hot zone is designed to operate at a maximum power of 5Mw and the low-temperature zone at 10 Mw. The design features of the reactor hot zone, helium turbocompressor, and the cyclone dust separator are given. Advantages and disadvantages of the design are discussed. (C.J.G.)

**4137**

PROCESS APPLICATIONS AND CONSTRUCTION MATERIALS FOR A HIGH-TEMPERATURE NUCLEAR REACTOR FOR CHEMICAL PROCESSING. Leon Davidson and Alfred A. Strasser (Nuclear Development Corp. of America, White Plains, N. Y.). Chem. Eng. Progr. 55, Symposium Ser. No. 22, 167-71(1959).

The design and application of a high-temperature process heat reactor at temperatures above 2000°F were studied. Several types of process cycles in which the problem of radioactive contamination of the product occurs are considered. The design of fuel elements and materials to operate above 2000°F is discussed. (C.J.G.)

**4138**

DOWNREAY FAST REACTOR. COMMISSIONING AND START-UP. J. L. Phillips (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). Nuclear Power 4, No. 44, 94-100(1959) Dec.

A summary is presented on construction, dry, metal, wet, and final approach tests employed in commissioning and start-up of the Dounreay Fast Reactor. (C.J.G.)

**4139**

DOWNREAY FAST REACTOR. INSTRUMENTATION AND CONTROL. K. R. Sandiford (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). Nuclear Power 4, No. 44, 100a-2a(1959) Dec.

The instrumentation for flux measurements in the Dounreay Fast Reactor is described. Design features of the coolant circuit and reactor power control system are described. A discussion is presented on special problems such as the use of liquid metal coolant, the relatively high temperatures in which a number of the instruments have to operate, and the necessity of connecting the instrument cables through the containment sphere. (C.J.G.)

**4140**

BUILDING DRESDEN. Nucleonics 17, No. 12, (65-8; 75) Dec.

The construction and design features of the Dresden nuclear power plant are discussed. Construction problems encountered in erecting the containment sphere and installing various reactor components and the pressure vessel are described. Component design and heat-transfer data are given. (C.J.G.)

**4141**

TURRET-A TEST OF UNCLAD FUEL. R. P. Hammond, W. R. Wykoff, H. M. Busey, J. D. Rogers, F. P. Durham, and K. R. Chapman (Los Alamos Scientific Lab., N. Mex.). Nucleonics 17, No. 12, 106-9(1959) Dec.

The design features and main test objectives of the Los Alamos Turret Reactor are discussed. The main objective of the test is the study of the effects of using porous unclad fuel elements on the reactor proper and the heat-transfer system. (C.J.G.)

## WASTE DISPOSAL AND PROCESSING

**4142** CF-59-11-6

Oak Ridge National Lab., Tenn.  
THE ORIGIN AND NATURE OF RADIOACTIVE WASTES IN THE ATOMIC ENERGY PROGRAM. F. R. Bruce, Nov. 30, 1959. 69p. OTS.

The sources from which radioactive wastes arise, their quantities, compositions, and properties which are pertinent in considering disposal methods are examined. The methods which are described for reprocessing U and Al-U alloys clad with Al are well established. There is, however, uncertainty in defining the nature of radioactive wastes from reactor fuel reprocessing because processing methods have not been selected, and for this reason several approaches to waste disposal are presented. Data and flowsheets for various processes are included. 82 references. (J.R.D.)

**4143** ORNL-2847

Oak Ridge National Lab., Tenn.  
RADIOACTIVITY IN SILT OF THE CLINCH AND TENNESSEE RIVERS. W. D. Cottrell. Dec. 7, 1959. 47p. Contract W-7405-eng-26. OTS.

Surveys of radioactivity in the Clinch and Tennessee rivers during 1954 through 1958 are summarized. It is concluded that no immediate hazard exists due to the re-concentration of radioactive materials in downstream bottom sediments. However, if the amount of radioactivity in the bottom sediment continues to increase for the next few years, it will be necessary to re-evaluate our present waste disposal policy in order to further restrict the release of radioactive wastes to the Clinch River. The most probable effect of the radioactive sediment on industry would be an increased background counting rate if sand from the river bottom were used in making concrete for the construction of counting rooms of instrument laboratories. The problem of the radioactivity in solution in the river water would have to be considered before using the downstream water as process water in the manufacture of film emulsions or other photographic materials. (auth)

**4144**

RADIOACTIVITY LEVELS AND TEMPERATURE VARIATIONS OF THE COLUMBIA RIVER. Royal E. Rostenbach (General Electric Co., Richland, Wash.). Chem. Eng. Progr. 55, Symposium Ser. No. 22, 37-43(1959).

The temperature and radioactivity levels of the Columbia River, primarily between Priest Rapids in Washington and Umatilla, Oregon, are given. The radioactivity levels at various distances in the Columbia River from the Hanford Plant are given. (C.J.G.)

**4145**

CORROSION STUDIES, CALCINING AQUEOUS RADIOACTIVE WASTES. E. J. Tuthill and R. F. Domish (Brookhaven National Lab., Upton, N. Y.). Ind. Eng. Chem. 51, 1471-4(1959) Dec.

A study was undertaken to measure the resistance of selected materials to corrosive conditions in calcination of simulated zirconium waste solutions in rotary ball kilns. One investigation centered on use of a 325 and a 700°C kiln in series for forming nitrogen oxides separately from hydrogen fluoride. A second involving a single-kiln unit was made because several alloys showed favorable resistance in the high temperature (defluorination) unit of the double-kiln apparatus. At least four alloys were found



suitable as materials of construction for single- or double-kiln apparatus for calcining radioactive wastes. (auth)

**4146**

INDUSTRIAL RADIOACTIVE WASTE DISPOSAL. HEARING BEFORE THE SPECIAL SUBCOMMITTEE ON RADIATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-SIXTH CONGRESS, FIRST SESSION ON INDUSTRIAL RADIOACTIVE WASTE DISPOSAL, JULY 29, 1959.

VOLUME 5. Washington, D. C., Joint Committee on Atomic Energy, 1959. p.3059-3142. (GPO)

The disposal of radioactive wastes into the Atlantic Ocean and Gulf of Mexico is discussed. Ten proposed dumping sites are shown on maps which cover the area from Galveston to Cape St. George. The biological effect of radiation on fish and the hazards to man arising from radioactive waste disposal close to the shoreline are discussed. (C.J.G.)

The first of these was the Declaration of Independence, which was adopted by the Continental Congress on July 4, 1776. This document declared the thirteen colonies to be free and independent states, no longer under British rule. The second was the Constitution, which was adopted by the delegates to the Constitutional Convention on September 17, 1787. This document established the framework for the federal government and the rights of the states. The third was the Bill of Rights, which was adopted by the first Congress on September 12, 1789. This document guaranteed the basic rights of the citizens, such as freedom of speech, religion, and the press. These three documents are the foundation of the United States government and its principles.

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